ASSOCIATION OPTIC NERVE SHEATH DIAMETER (ONSD) ON ULTRASOUND WITH PROGNOSIS IN ACUTE CEREBRAL VENOUS THROMBOSIS (CVT)

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Submitted By

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Dedicated

to

my Family

&

Teachers

ABBREVIATIONS

ONSD	OPTIC NERVE SHEATH DIAMETER
ARMT	ABNORMAL RESIPIRATORY MODULATE BLOOD FLOW
CTV	COMPUTED TOMOGRAPHY VENOGRAPHY
CVST	CEREBRAL VENOUS SINUS THROMBOSIS
CVT	CEREBRAL VENOUS THROMBOSIS
eFAST	EXTENDED FOCUSED ASSESMENT WITH SONOGRAPHY IN TRAUMA
GCS	GLASGOW COMA SCALE
ICP	INTRA CRANIAL PRESSURE
LP	LUMBAR PUNCTURE
MRS	MODIFIED RANKIN SCALE
MRV	MAGNETIC RESONANCE VENOGRAPHY
NPV	NEGATIVE PREDICTIVE VALUE
ODE	OPTIC DISK ELEVATION
PPV	POSITIVE PREDICTIVE VALUE
RI	RESISTIVE INDEX
RVP	RETINAL VENOUS PULSATION
SD	STANDARD DEVIATION

ABSTRACT

Introduction: Cerebral venous thrombosis (CVT) is a condition characterized by thrombosis of intracranial sinuses and veins that results in parenchymal damages and can cause increased intracranial pressure.

Aim of Study: The aim of the study is to find association of the optic nerve sheath diameter changes with prognosis in acute cerebral venous thrombosis patients.

Materials & methods: This will be an observational prospective study conducted in the department of emergencymedicine at Dayanand Medical College and Hospital (DMC&H), Ludhiana on patients diagnosed with acute cerebral venous thrombosis(CVT) and optic nerve sheath diameter of both the eyes will be done with the ultrasound. The study will be conducted over a period of 1 and half years.

Results: 34 patients of CVT were included in the study with 20 males and 14 females. There was a strong and significant correlation of measurement of ONSD in patients with CVT for assessment of ICP (Intracranial Pressure) while serial measurement of ONSD at day 4 also had good correlation with the outcome.

Conclusion: From the results of the present study, it can be concluded that ONSD is a valid non-invasive triage tool with high sensitivity value which can be used to detect the raised intracranial pressure in patients of CVT. Ultrasonography of the ONSD may serve as a safe, rapid, non-invasive, and low-cost bedside tool for the dynamic and quantitative evaluation of ICP changes, especially if repeated evaluations are needed.

Keywords: Cerebral vein thrombosis, mRS, OND, outcome.

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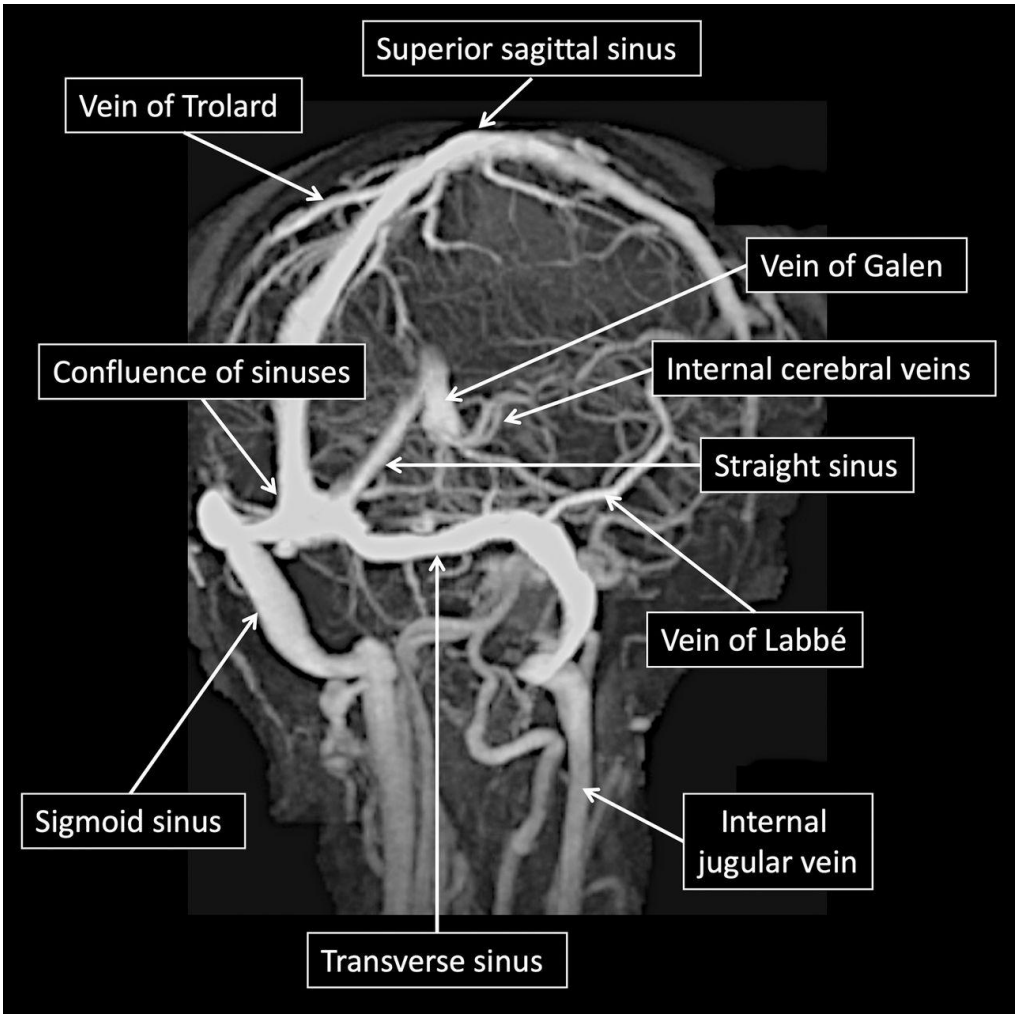
INTRODUCTION

Cerebral venous thrombosis (CVT), which includes thrombosis of the cerebral veins and the dural sinuses, is a rare disorder that can lead to significant morbidity and mortality. Cerebral venous thrombosis is an important cause of stroke in young adults (mean age 33 years with a two-thirds female preponderance)[1] caused by complete or partial occlusion of the cerebral major cerebral venous sinuses (cerebral venous sinus thrombosis) or the smaller feeding cortical veins (cortical vein thrombosis). CVT is frequently missed or diagnosed late because it can mimic other acute neurological conditions and can only be recognised with optimal and timely brain imaging.[2] CVT was found in 9.3% of one consecutive autopsy series,[3] suggesting that it might often be missed in life. CVT generally has a favourable prognosis if diagnosed and treated early.[4] The mainstay of acute treatment is anticoagulation with parenteral heparin, but patients who deteriorate despite treatment can be considered for endovascular procedures (endovascular thrombolysis or thrombectomy) or neurosurgery (decompressive craniotomy).[5,6]

CVT accounts for 0.5–1.0% of unselected stroke admissions[7] and is about three times as common in women than men,[8,9] probably partly due to its association with pregnancy, the puerperium and the use of oestrogen-containing oral contraceptives.[10]

Cerebral venous thrombosis can present with variable signs and symptoms that include a headache, benign intracranial hypertension, subarachnoid hemorrhage, focal neurological deficit, seizures, unexplained altered sensorium, and meningoencephalitis.[11,12] The diversity of risk factors and variable presentation present challenges in diagnosing cerebral vein thrombosis. Delay in diagnosis is common, as the median delay from symptom onset to hospital admission is four days and from symptom onset to diagnosis is seven days. Thus, having a high index of suspicion for this disorder is crucial to ensure timely diagnosis and treatment.[13,14]

Blood from the brain drains through small cerebral veins into larger veins of the deep venous system (including the internal cerebral veins, basal veins (of Rosenthal) and vein of Galen), which then empty into dural sinuses (including the straight sinus, transverse sinuses and sagittal sinus); these in turn drain mainly into the internal jugular veins (Picture 1). Changes in blood stasis, vessel wall abnormalities and the composition of the blood (Virchow's triad) lead to an imbalance between prothrombotic and fibrinolytic processes, predisposing to progressive venous thrombosis. Obstruction of venous vessels induces increased venous pressure, reduced capillary perfusion and locally increased cerebral blood volume. Although initially compensated for by the dilatation of cerebral veins and the recruitment of collateral vessels, continued elevation of venous pressure can cause vasogenic oedema (due to blood–brain barrier disruption) and decreased cerebral perfusion pressure and cerebral blood flow with tissue infarction;[15] thus, both cytotoxic and vasogenic oedema can occur.[16] The venous territories are less well defined than are arterial territories due to extensive anastomoses between cortical veins, which allow the development of alternative venous drainage pathways after an occlusion. CVT can also block cerebrospinal fluid absorption through the arachnoid villi, which then leads to raised intracranial pressure (with or without tissue injury), typically in association with superior sagittal sinus obstruction. These pathophysiological changes can cause the typical focal neurological symptoms and signs of CVT, which depend on the territory of the brain that has impaired venous drainage, the acuity of the occlusion (sudden or gradual), the degree of collateralisation and the degree of associated tissue injury. The slow growth of the thrombus and collateralisation of venous vessels probably accounts for the often gradual onset of symptoms, frequently over days, weeks or even months.



Picture 1: Time of-flight MR venogram of the normal major cerebral veins and venous sinuses.

(Image courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 51 158).

In the acute phase, patients are at risk of cerebral herniation and death due to elevated intracranial pressure. In addition to anticoagulation, patients may require measures to decrease pressure within hours of symptom onset, including emergent decompressive hemicraniectomy.[8] Despite advances in diagnostic techniques, a misdiagnosis occurs in 1 out of 30 patients in the emergency setting.[17] The mortality rate in the acute phase is ~3-15%, and around 10% develop secondary complications like haemorrhage, vision loss, and neurological deficits.[4,8,18]

Direct intracranial pressure (ICP) monitoring methods, such as lumbar puncture (LP) and intraventricular catheterization, are commonly used to detect ICP. However, these invasive techniques can result in complications, such as haemorrhaging and bacterial colonization,[19,20] and involve pain and discomfort, especially if repeated evaluations are needed. In addition, invasive ICP monitoring is sometimes unavailable in intensive care units or to patients with certain serious conditions. Given this, non-invasive, repeatable, simple methods for assessing ICP are urgently needed.

As the subarachnoid space continues along the optic nerve within the optic nerve sheath, which is an extension of the dura mater. There is growing interest in the use of the optic nerve sheath diameter (ONSD) as a surrogate non-invasive marker of ICP.[21] However, this technique was used to evaluate the elevated ICP caused by severe traumatic brain injury and few studies reported the cases that prompt this technique could dynamically assess the efficacy of management of elevated ICP.[22] Raised ICP is transmitted through the CSF within this sheath causing a measurable increase in the ONSD. Currently, ONSD can be evaluated with ultrasonography, magnetic resonance imaging (MRI), and CT scans. The optic nerve sheath has a high spatial resolution on magnetic resonance imaging (MRI). Measurement of the optic nerve sheath by MRI may be an ideal reference due to high spatial resolution.

Acute and chronic diseases with an increase in ICP (e.g., idiopathic intracranial hypertension, craniocerebral trauma, malignant middle cerebral artery stroke, intracranial hemorrhage, decompensated hydrocephalus) lead to an increase of ONSD. In cases where the increase of ICP persists, a congested papilla develops with optic disc elevation (ODE), which can be detected with ultrasonography. Furthermore, some recent papers indicate that a diminution of ICP can provoke a decrease in ONSD. Dynamic measurement including a comparison of lying and standing positions can then help further to identify symptomatic intracranial hypotension.[23,24]

A variety of potential applications of ONSD has been explored, important being detecting high ICP in Intracranial hemorrhage and ischemic stroke. Naldi A et al.,[25] reported sensitivity and specificity of 100% for ONSD for the detection of increased ICP compared to the Doppler indices, among patients of ICH. Skoulodik D et al.,[26] found an enlarged ONSD even in the hyperacute phases of acute ICH within 6 h of the symptom onset ($p < 0.0083$), with the best cut-off point to predict intracranial hemorrhage volume of > 2.5 cm3 corresponding to an ONSD enlargement of > 0.66 cm (> 21%), with 90.3% accuracy and interrater reliability of 0.760 (95% CI 0.509 to 1.000). Gökcen E et al.,[27] found that ONSD could identify middle cerebral artery (MCA) stroke patients at high risk of developing malignant MCA syndrome, permitting early diagnosis of a possible ICP increase using ONSD with the possible benefit of decreasing mortality and morbidity in patients with cerebrovascular diseases. Albert AF et al.,[28] also found the same results. Barring few studies,[22] literature lacks research showing the use of USG guided ONSD measurement in patients with CVT, however the fact seems convincing that patients of stroke are prone to increased levels of ONSD and its cut off may be used to predict the increasing ICP which may lead to poor outcomes. In the neurological settings, this association of increase in ONSD among CVT patients may be helpful in deciding a preventable course of management for the patients.

In order to ascertain the ONSD diameter changes in CVT patients and their relationship to short-term outcomes, the current investigation was undertaken. Understanding the changes in ONSD diameter that occur when CVT occurs may aid in forecasting the rise in ICP that may have management implications. The study's findings might be useful for a portion of CVT patients who appear in neurological settings, allowing for an earlier diagnosis and better management.

AIMS AND OBJECTIVES

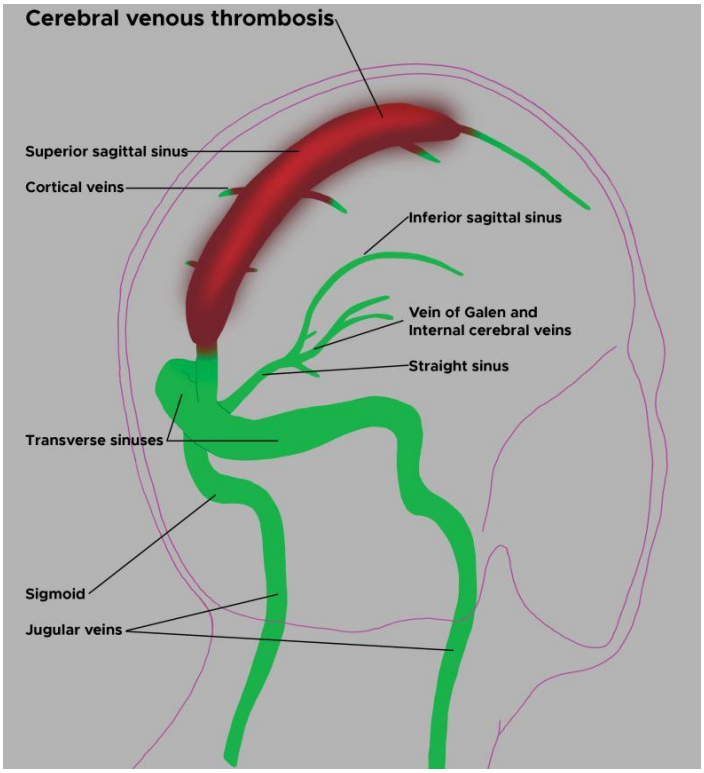
- To study the relationship between Optic Nerve Sheath Diameter (ONSD) with acute CVT (cerebral venous thrombosis) during hospital stay and in-hospital mortality.
- Primary outcome is death or disability
- Disability was assessed by mRS, mRS>> 3

  << 3
- Secondary outcome was duration of hospital stay and need for mechanical ventilation.

REVIEW OF LITERATURE

CEREBRAL VENOUS THROMBOSIS

Cerebral venous thrombosis (CVT), also called cerebral venous sinus thrombosis (CVST), is a cerebrovascular disease (Picture 2) with diverse clinical manifestations that often affects young adults, women of childbearing age, and children. It's most common clinical manifestations are headache, seizures, altered consciousness, and neurological focal signs on physical examination.CVT is a special type of cerebrovascular disease that present with focal cerebral edema, venous cerebral infarction, seizures, and intracranial hypertension as its most prominent clinical features.[10,29] More importantly, CVT has received an increased amount of attention by clinicians.



Picture 2: Illustration of cerebral venous thrombosis.

Superior sagittal sinus, cortical veins, inferior sagittal sinus, Vein of Galen, internal cerebral veins, straight sinus, transverse sinus, sigmoid, jugular veins.

Etiology

Many risk factors contribute to the development of cerebral venous thrombosis. At least one risk factor was identified in more than 85% of patients with cerebral venous thrombosis, and multiple risk factors are found in more than 50% of patients with cerebral venous thrombosis.[30]

In general, cerebral venous thrombosis is common in any condition that leads to a prothrombotic state, including pregnancy, the post-partum state, or those on oral contraceptives. In the International Study on Cerebral Vein and Dural Sinus Thrombosis (ICSVT), genetic and acquired thrombophilia were present in 34% of patients with cerebral venous thrombosis. Inherited thrombophilia includes protein C and protein S deficiencies, antithrombin deficiency, factor V Leiden mutation, prothrombin gene mutation 20210, as well as hyperhomocysteinemia.[31,32]

Acquired thrombophilia should be suspected in patients with a history of nephrotic syndrome (due to loss of antithrombin) or antiphospholipid antibodies. Additional causes and risk factors associated with cerebral venous thrombosis include chronic inflammatory disease states such as systemic lupus erythematosus, inflammatory bowel disease, malignancy, and vasculitides such as Wegener's granulomatosis. Local infections such as otitis and mastoiditis, which can lead to thrombosis of the adjacent sigmoid and transverse sinuses, have also been implicated in developing cerebral venous thrombosis. Cerebral venous thrombosis may also be seen in a patient with a head injury, after certain neurosurgical procedures, direct injury to the sinuses or jugular veins, such as jugular vein catheterization, and even after a lumbar puncture.[33,34]

Epidemiology

Cerebral venous thrombosis is a rare disorder with an annual incidence estimated to be three to four cases per million. The frequency of peripartum and post-partum cerebral venous thrombosis is about 12 cases per 100,000 deliveries in pregnant women, which is only slightly lower than that of peripartum and post-partum arterial stroke. Cerebral venous thrombosis occurs three times more frequently in women than

in men. This is thought to be due to gender-specific risk factors, for example, oral contraceptive use and, less frequently, pregnancy, puerperium, and hormone replacement therapy. More recently, there has been a significant female predominance among young adults, with the majority of cases (70% to80%) being in women of childbearing age, but not among children or elderly persons.

Pathophysiology

There are two pathophysiologic mechanisms thought to contribute to the clinical manifestations of cerebral venous thrombosis. First, thrombosis of the cerebral veins leads to increased venous and capillary pressure, which leads to a decrease in cerebral perfusion. Decreased cerebral perfusion results in ischemic injury, manifested by cytotoxic edema, which damages the energy-dependent cellular membrane pumps and leads to intracellular swelling. Disrupting the blood-brain barrier leads to vasogenic edema and leakage into the interstitial space. The increased pressure in the venous system can lead to an intraparenchymal hemorrhage.

The second pathophysiologic mechanism resulting in cerebral venous thrombosis is obstruction of the cerebral sinuses, particularly when the thrombus does not resolve. Normally, the cerebrospinal fluid found in the cerebral ventricles is transported through the subarachnoid space to the arachnoid granulations and absorbed into the venous sinuses. Thrombosis of the venous sinuses results in impaired cerebrospinal fluid absorption, ultimately leading to increased intracranial pressure. Increased intracranial pressure leads to cytotoxic and vasogenic edema and may result in parenchymal hemorrhage.

History and Physical

Physicians should highly suspect cerebral venous thrombosis given the variable presentation and low annual incidence. Signs and symptoms may be acute, subacute, or chronic, with the most common symptom in cerebral venous thrombosis being a headache. Pathophysiological changes can cause the typical focal neurological symptoms and signs of CVT, which depend on the territory of the brain that has impaired venous drainage (Picture 3). A subacute pattern of the clinical

presentation was observed in almost 60% of cases compared to acute (<48 hours in 37%) and chronic (>30 days in 7%).[30] A headache presents in up to 90% of patients.[30]

Headaches may be generalized or diffuse and tend to mimic migraines but may increase in severity slowly over days and weeks and are not relieved with sleep. In some instances, the headache may be thunderclap in nature, starting suddenly and maximal in intensity at onset, thereby mimicking the presentation of subarachnoid hemorrhage. A headache is often worsened with Valsalva or coughing, indicative of increased intracranial pressure. Papilledema and visual symptoms, such as diplopia caused by a sixth cranial nerve palsy when the intracranial pressure is too high, may accompany a headache. The funduscopic examination will reveal papilledema, which,depending on the severity, can cause visual impairment and even permanent blindness if left untreated. However, an isolated headache without any other focal neurologic deficits or papilledema has been reported in up to a fourth of patients with cerebral venous thrombosis and further complicates the diagnostic picture.

Focal neurologic signs are common and are seen in up to 44% of patients. Motor weakness, including hemiparesis, is the most common focal finding. However, unlike arterial thrombosis in the setting of cerebrovascular accidents, localization to one vascular territory is often absent. Hemispheric symptoms, such as aphasia and hemiparesis, are a characteristic but rare finding. Seizures are seen in about 40% of patients with cerebral venous thrombosis, the most common of which are focal seizures. Focal seizures account for 50% of those who experience a seizure in the setting of cerebral venous thrombosis but have the potential to generalize to a status epilepticus. Thus, cerebral venous thrombosis should be considered in any patient who presents with a headache and some combination of either focal neurologic deficit or new-onset seizures. Thrombosis of the straight sinus, or in severe cases of venous infarction with hemorrhagic transformation, can lead to compression of the diencephalon and brainstem, resulting in coma or death due to cerebral herniation.[35]

Occluded sinus/ vein	Clinical presentation
Transverse sinus (44–73%)	If isolated without infarction: asymptomatic or headache Seizures Contralateral pyramidal symptoms and signs If left transverse sinus with venous infarction and vein of Labbé occlusion: aphasia If extending into the contiguous sinuses: intracranial hypertension, consciousness disturbance, focal cerebral signs and cranial nerve palsies (IX-XXI) If extending into the cerebellar veins: headache, vomiting, and limb or gait ataxia.
Superior sagittal sinus (39–62%)	Isolated intracranial hypertension Focal symptoms due to venous infarction (see below) Isolated psychiatric symptoms (rare) ▶ Headache ▶ Blurred vision ▶ Visual loss ▶ Nausea, vomiting ▶ Cranial nerve palsy (differential diagnosis of pseudotumor cerebri) ▶ Aphasia ▶ Hemianopia ▶ Hemisensory loss and/or hemiparesis ▶ Seizures
Sigmoid sinus (40–47%)	Pain in the mastoid region Combinations of VI-VII-VIII cranial nerve palsies
Deep venous system (10.9%)	Mental status disturbances—reduced arousal Diffuse encephalopathy or coma Motor deficits (bilateral or fluctuating alternating paresis)
Cortical veins (3.7–17.1%)	Focal neurological symptoms and signs according to location Seizures
Cavernous sinus (1.3–1.7%)	Headache, ocular pain, chemosis, proptosis, ocular nerve palsy (III, IV, VI and the ophthalmic division of V) Fever (when there is an infective cause)

Picture 3: Clinical manifestations of cerebral venous thrombosis according to occlusion site

Evaluation

Diagnosis of cerebral venous thrombosis is clinical and confirmed with neuroimaging. Given its varied presentation and myriad of symptoms, one must have a high index of suspicion to identify and diagnose this rare and potentially life-threatening condition correctly. It should be suspected in young and middle-aged patients, especially those with cerebral venous thrombosis risk factors, such as postpartum women,

those with genetic or acquired thrombophilia, and patients with focal neurological findings. It should also be suspected in the following:

- Under the age of 50
- Who present with atypical headaches or those having multiple repeat evaluations for an unrelenting headaches
- Focal neurological deficit
- Stroke-like symptoms, especially in the absence of vascular risk factors that would predispose to cerebral vascular accidents (carotid atherosclerosis)
- Seizures (focal, generalized, or status-epilepticus)
- Intracranial hypertension or evidence of papilledema on funduscopic exam
- Patients with CT evidence of hemorrhagic infarcts, particularly in the setting of multiple infarcts not confined to a single vascular territory

Some important clinical clues to the diagnosis include slow progression, bilateral involvement, and concurrent seizures.[30]

Laboratory evaluation should include a complete blood count, coagulation panel, chemistry panel, as well as inflammatory markers such as a sedimentation rate and C-reactive protein to evaluate for proinflammatory states. Ideally, a screening test that could effectively rule out the diagnosis without subjecting patients to neuroimaging when it is not necessary would be ideal and prove helpful to clinical practice. The D-dimer assay has been evaluated in this regard, and unfortunately, it has been shown to have an unacceptable false-negative rate of up to 26% in one study. This low sensitivity of the D-dimer assay is in contrast to the utility of the D-dimer in ruling out deep venous thrombosis, which may be due to the lower thrombotic burden of cerebral venous thrombosis compared to DVT.[36,37]

Based on recent American Heart Association/American Stroke Association guidelines, a negative D-dimer does not effectively rule out cerebral venous thrombosis and should not preclude neuroimaging if there is clinical suspicion for cerebral venous thrombosis.[38,39]

However, adding D-dimer (≥500 µg/L) to the clinical CVT score (comprising of variables such as seizure, known thrombophilia, oral contraceptive use, duration of symptoms for >6 days, worst headache ever, and focal neurologic deficits) has shown to improve its predictive value.[40]

Neuroimaging

1. **Non-contrast computed tomography (CT)**: The speed and accessibility with which this test can be obtained make it the first test that should be obtained in any patient presenting with an atypical headache, focal neurologic deficit, seizures, altered mental status, or coma. A direct sign of cerebral venous thrombosis is the cord sign, a curvilinear hyperdensity within a cortical vein in the presence of thrombosis that can be seen for up two weeks following thrombus formation. Other direct signs include hyperdensity with a triangular shape in the superior sagittal sinus, also known as the dense triangle sign. Intraparenchymal hemorrhages or infarcts may be seen on non-contrast head CT and may cross vascular boundaries. In a multicentric study, brain infarction was observed in 36.4%, hemorrhagic transformation in 17.3%, and intraparenchymal hemorrhage in 3.8% of cohorts.[30] Hyperdensity within a cortical vein or dural sinus in plain CT is observed in only one-third of the cases.[30]
2. **CT Venography (CTV)**: While MRI does have a better sensitivity and specificity when compared to computed tomography, diagnostic and confirmatory venography is required to exclude cerebral venous thrombosis. The presence of new, helical CT scanners has led to evidence that CT venography is superior in the identification of cerebral veins when compared to MR venography and that the two methods are equivocal in the identification and diagnosis of cerebral venous thrombosis. The fact that CT venography can rapidly be performed following a non-contrast head CT while the patient is still in the CT scanner makes CT venography a viable option in the emergency setting

when access to MRI imaging and venography may otherwise be limited or unavailable. Contrast-enhanced computed tomography illustrates the empty delta sign, representing contrast enhancement flowing around the comparatively hypodense region of the thrombosed superior sagittal sinus.

3. **Magnetic resonance imaging (MRI) and magnetic resonance venography (MRV)** are considered the gold standard in diagnosing cerebral venous thrombosis as they have a higher sensitivity than computed tomography. MRI is superior to CT when evaluating for parenchymal edema as a result of cerebral venous thrombosis. MRI findings are dependent on the age of the thrombus, as signal intensities change depending on thrombus age. Thus, MRI interpretation requires a detailed understanding of the evolutionary changes seen radiographically. An acutely formed thrombus (0 to 7 days) is harder to detect, but by week 2, abnormalities are easier to detect, with both T1 and T2-weighted images showing a hyperdense signal. The combination of an abnormal signal in a venous sinus combined with the absence of flow on MRV confirms the diagnosis of cerebral venous thrombosis. 2-dimensional lumen-based TOF showing the absence of a flow void in the dural sinus is the most sensitive imaging modality. Multiscale entropy (MSE) of hemoglobin products within the thrombus is of high diagnostic value.[41] The presence of DWI abnormality within the involved veins or sinus indicates low chances of recanalization. The differentials include arachnoid granulations and fenestrations.[42]
4. **Cerebral angiography**: If the diagnosis is still in question after using MRI and MRV, then intra-arterial angiography is indicated. Angiography allows for superior visualization of the cerebral veins and helps identify anatomical variants of normal venous anatomy that mimic cerebral venous thrombosis. It is useful in rare cases of isolated cortical vein thrombosis without sinus thrombosis and may show indirect signs such as dilated and

tortuous "corkscrew" collateral veins, evidence that there may be thrombosis further downstream of the sinuses.

Superior sagittal sinus is most frequently involved, followed by transverse sinus.[30]

Management

Management initially focuses on identifying and addressing life-threatening complications of cerebral venous thrombosis, including increased intracranial pressure (ICP), seizures, and coma. If a patient seizes and has a lesion such as a hemorrhage or infarction on neuroimaging, then specific anticonvulsant therapy, as well as seizure prophylaxis, should be initiated. If a seizure does not occur, then seizure prophylaxis is not indicated. In the case of increased ICP, the head of the bed should be elevated, and administration of dexamethasone and mannitol should be done promptly to reduce increased ICP. This is followed by admission to the intensive care unit or stroke unit for close ICP monitoring, with a neurosurgical consultation if the patient decompensates and requires surgical decompression. Next, attention should be shifted to specific therapy, including anticoagulation and, in certain cases, catheter-directed fibrinolysis and surgical thrombectomy.

OPTIC NERVE SHEATH DIAMETER

Optic nerve sheath diameter has significance in the assessment of papilledema in cases of elevated intracranial pressure. The optic nerve sheath demonstrates changes in diameter with CSF pressure changes as there is a layer of subarachnoid space between the nerve and its sheath, which expands due to raised intracranial pressure. These changes are appreciated more along the anterior aspect of the nerve.

Optic nerve sheath ultrasound

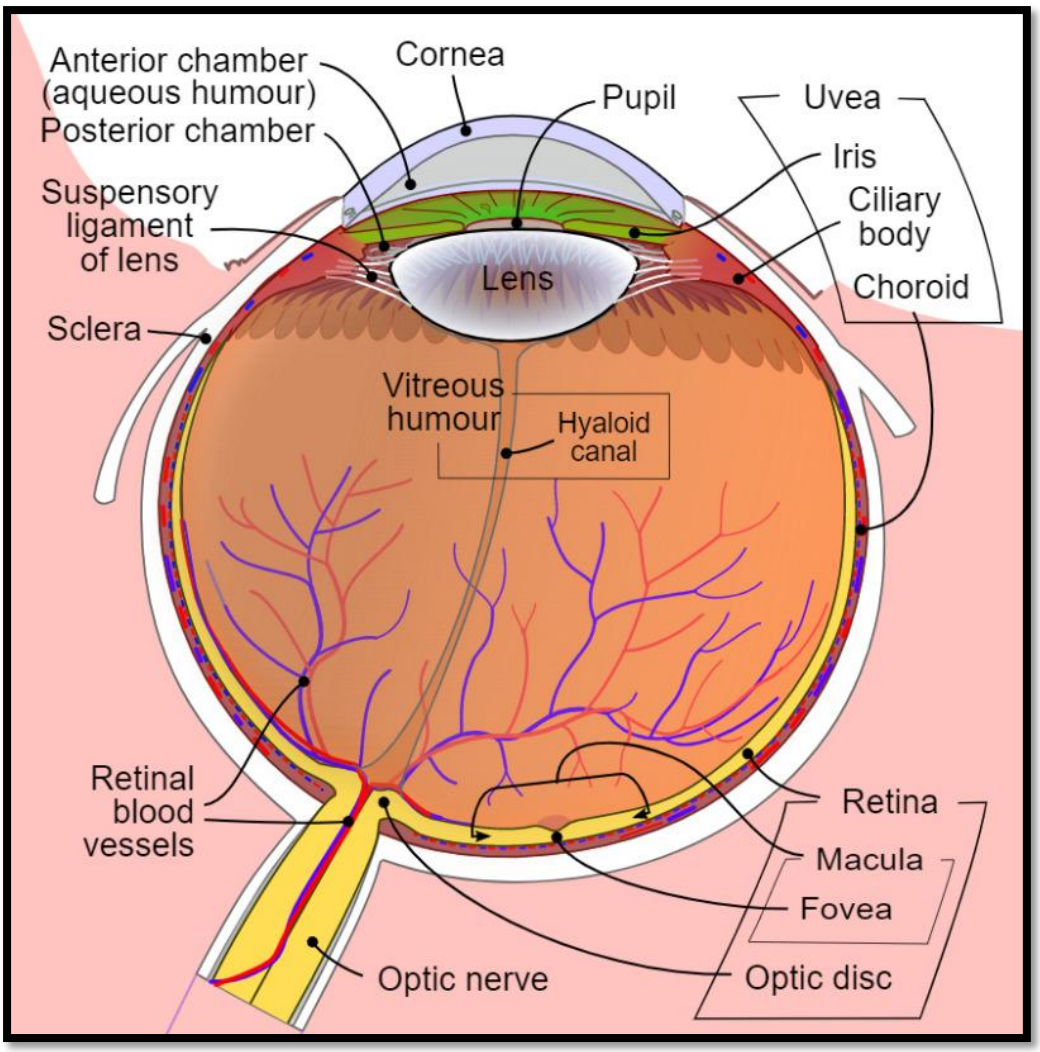
With small, portable ultrasound models becoming available, advanced diagnostics are becoming more accessible in remote environments and on the battlefield. Physicians are becoming trained to perform extended focused assessment with sonography in trauma (eFAST), optic nerve sheath ultrasound (ONSUS) for the evaluation of intracranial hypertension, inferior vena cava collapsibility assessments for the

evaluation of volume status, and countless other examples of image-guided procedures.[43,44]

Anatomy and Physiology

The eye (Picture 4) is an ideal configuration for ultrasound imaging as it is superficial with well-demarcated fluid-filled structures that serve as an excellent medium for ultrasound beam transduction. Identifying anterior structures will increase success in measuring the optic nerve sheath in the correct plane.

The eyeball rests in a membranous sac called the Tenon capsule, surrounded by periocular fat, soft tissue, and the orbital walls. It attaches via the corneoscleral junction and the optic nerve, with extraocular muscle tendons piercing the Tenon sac, inserting into the sclera, and allowing for eyeball mobility on multiple axes. Two fluid-filled structures that require identification in the study include the anterior chamber (AC) and posterior chamber (PC), which are separated by the lens and both harbor anechoic fluid. Posterior to the PC is the retina with a hyperechoic nervous membrane.[45]



Picture 4: Diagram of the human eye.

(It shows the lower part of the right eye after a central and horizontal section)

Posterior to the retina and optic disc, one can identify the optic nerve by its anechoic core, flanked by a hyperechoic sheath on the medial and lateral borders in the transverse plane. The optic nerve can be thought of as an outpouching of intact brain tissue with the intraorbital component fully encapsulated by dura, arachnoid, and piamatter, allowing the optic nerve sheath to transmit cerebral spinal fluid and fluctuate in size based on changes in intracranial pressure.[46,47] The meningeal cover of the optic nerve is the continuation of the dural and subarachnoid space.[48] The bulbous portion of the optic nerve, approximately 3 mm posterior to the globe, appears to be the most

distensible and sensitive to changes in ICP based on in-vivo models of elevated ICP and artificial creations of elevated ICP in cadaveric models.[46,49]

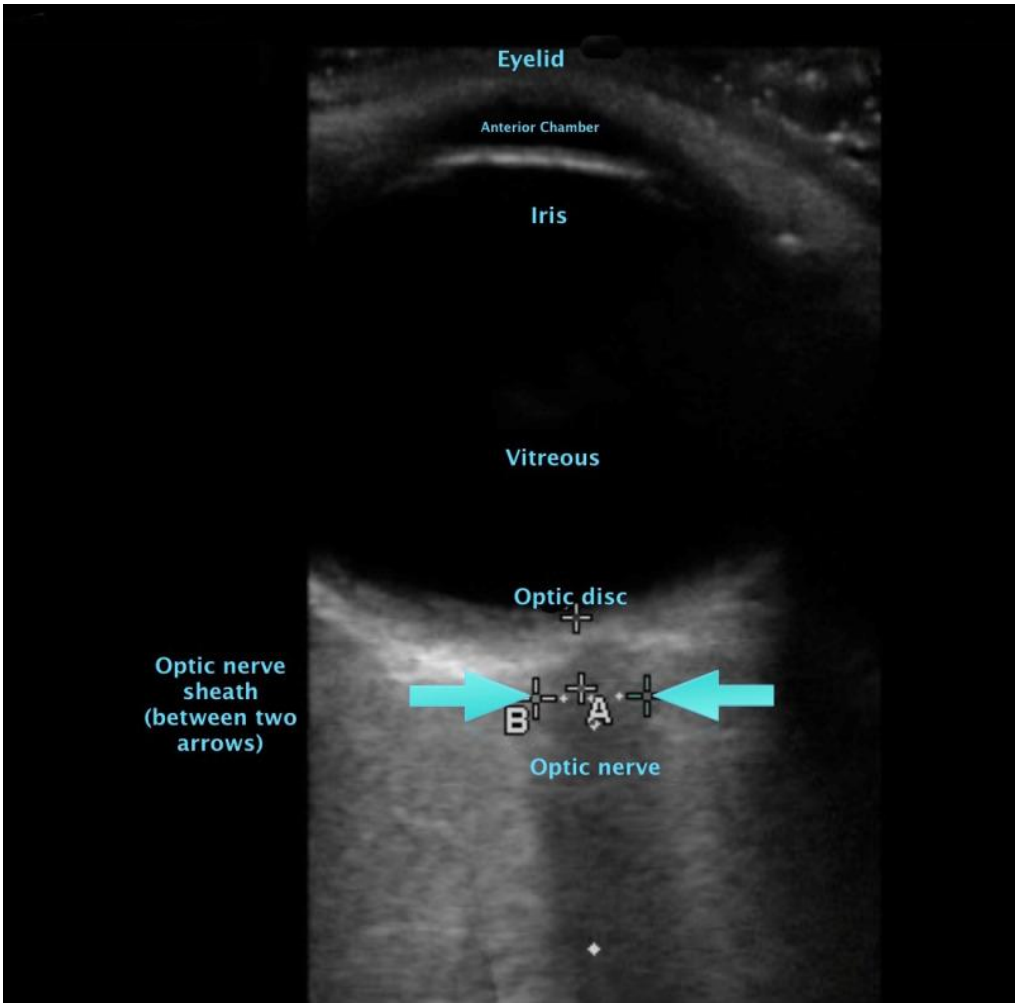
The upper limit of the normal optic nerve sheath diameter (ONSD)includes:

- 4 mm in infants.
- 5 mm in children.
- 5 mm in adults.

ONSD shows linear increment till 7.5 mm, after which it plateaus off.[50]

Indications

Ocular ultrasound can be performed for various reasons, including vision loss, headache, and trauma. It can be very beneficial in identifying or excluding retinal detachment, foreign bodies, lens dislocation, vitreous hemorrhage, and other superficial abnormalities that can cause loss of eyesight. ONSUS is usually performed in the setting of suspected or confirmed traumatic brain injury (TBI), intracranial hypertension, or optic neuritis.[51] ONSUS is non-invasive and avoids the risk of infection, hemorrhage, or ionizing radiation that are inevitable with intracranial monitors and computed tomography (CT).[52]



Picture 5: Optic nerve sheath measurement.

ONSUS can also be used to help “rule out” elevated ICP in non-acute trauma settings, such as troubleshooting a malfunctioning intraventricular device, before or following lumbar punctures, or while evaluating the safety of neuraxial anesthesia in patients with a previous history of elevated ICP. It should be emphasized that these readings should be evaluated in the overall clinical context, as such applications are not well studied or validated.[53-57]

ONSD is currently considered the best non-invasive modality for dynamic estimation of ICP.[58] ICP can be calculated using the formula ONSD: nICPONSD = 5.00 × ONSD − 13.92 mmHg.[59] This is a holy grail in assessing critical patients in whom invasive ICP monitoring is either unavailable or is contraindicated.[58] This has been found helpful in the evaluation of the following cohorts of patients:

1. Idiopathic intracranial hypertension.[60,61]
2. Intracranial hypotension.[62]
3. Hypoxic-ischemic encephalopathy.[48]
4. Perioperative neurosurgical patients.[63]
5. Shunt evaluation.[64]
6. Head injury.[65]
7. Ischemic strokes- With every 0.1 cm increment in ONSD, the odds ratio for mortality increased 4.2 times.[66,67]
8. Hematoma progression in hemorrhagic strokes.[68]

Contraindications

Surface ultrasound remains a safe modality with little to no risk to adult patients. However, if an open globe injury is suspected, there is potential for further ocular injury, and the study should not proceed without consultation or assistance from an ophthalmologist.[69,70]

Enhancing Healthcare Team Outcomes

Systematic review and meta-analysis have shown that ONSD of more than 5.00 to 5.70 mm has a concurrent ICP value above 20 mm Hg.[64,71] Systematic review and meta-analysis showed a mean ONSD in the included studies of 5.82 mm.[72]

ONSD/eyeball transverse diameter (mean value of 0.18) is more reliable than ONSD measurement alone.[48,73] This is accountable due to the following reasons:

- Significant correlation between ONSD and ETD
- Standard deviation between the normal and pathological values for ONSD is often overlapping
- The ratio is independent of demographic variables such as sex, height, weight, and BMI.[48]

ONSD reacts to ICP in real-time. Within the effective range, the chances of plastic deformation and over-distention of the ONS are minimal.[74,75] It is a very useful adjunct to other standard diagnostic modalities.[72] However, unified methods and a range of ONSD values must be established.[76]

Consensus on the ONSD monitoring as a non-invasive surrogate marker of intracranial pressure monitoring has advocated a checklist for quality assurance pertaining to probe selection, patient safety, positioning, image acquisition, and methods of measurement.[77]

In this literature review, studies done by various researchers have been discussed that evaluated ONSD in stroke patients with either arterial or venous causes or cerebral hemorrhage.

Skoloudík D et al., (2011)[26] included 31 acute intracerebral haemorrhage (ICH) patients, 15 age-matched acute ischemic stroke patients and 16 age-matched healthy volunteers. It was found that in acute ICH patients, a significant enlargement of ONSD was detected ($p < 0.0083$). The best cut-off point to predict ICH volume >2.5 cm^3 was the relative ONSD enlargement of > 0.66 mm (> 21 %), with 90.3% accuracy and kappa coefficient 0.760 (95% CI 0.509 to 1.000). Results showed that sonographically measured enlargement of the ONSD may be detectable in the hyperacute stage of increased intracranial pressure.

Bäuerle J et al., (2016)[78] studied 27 patients with aneurysmal subarachnoid hemorrhage (SAH) and found that in spite of the normal mean ICP values, ONSD was significantly greater in patients with SAH than that of healthy volunteers. No relevant decline of ONSD over time was found. Additionally, there was no correlation between ONSD and ICP. Results showed that in patients with SAH and acute hydrocephalus after aneurysm rupture, the ONSD was expanded after normalization of ICP. This may be probably because of an impaired retraction capability of the optic nerve sheath. This finding should be considered when using transorbitalsonography in the neuromonitoring of aneurysmal SAH.

Albert AF et al., (2017)[28] in study included a total of 19 patients with malignant MCA stroke and 19 patients with non malignant MCA stroke were enrolled. It was found that mean ONSD, ONSD/ETD (eyeball transverse diameter) ratio, midline shift (MLS), and infarct volume on initial CT all significantly increased after developing malignant MCA syndrome and decreased (except infarct volume, which increased)

following DC (P<.05). ONSD and ONSD/ETD ratios in the malignant group did not correlate with functional outcomes but were significantly higher on initial CT compared with the non malignant group (mean ONSD: 5.66 mm versus 4.97 mm, P = 0.001; mean ONSD/ETD ratio: 0.25 versus .22, P = 0.002). Results showed that ONSD, ONSD/ETD ratio, MLS, and infarct volume change dynamically in patients with malignant MCA infarction who undergo DC. An ONSD of > 5.25 mm and an ONSD/ETD ratio of > .232 on initial CT may identify MCA stroke patients at high risk of developing malignant MCA syndrome.

Gökcen E et al., (2017)[27] in the study included the patients with the symptoms of stroke. Patients were categorized into four subgroups as per Oxfordshire Community Stroke Project classification (OCSP). It was found that on comparing the right and left ONSDs of CVD group and control group, the results were statistically significant (p<0.001). When the CVD subgroups were compared with the control group in terms of right and left ONSDs, the highest right-left ONSD was detected to be in TACI (total anterior circulation infarction) group (p<0.001). Results showed that in the early cases of CVD, mortality and morbidity can be reduced by the early diagnosis of the possible existence of ICP increase as per the ONSD level.

Yesilaras et al., (2017)[79] in study included 61 patients with spontaneous SAHs and equal number of control patients. The median ONSD for control was significantly lesser than spontaneous SAH (5.76 vs. 6.72 mm, p<0.001). The AUC (area under the receiver operating characteristic curve) was determined as 0.791 (CI 95%, 0.710-0.872). At an ONSD threshold value of 6.1 mm, the sensitivity and specificity of SAH was 72%. No significant relationship between ONSD and in-hospital mortality in spontaneous SAH patients (p>0.05) was observed. The intraclass correlation coefficients for inter- and intrarater reliability were 0.84 and 0.95, respectively. Results showed that in patients who have spontaneous SAH, the ONSD measured in the orbital sections of a head CT was strongly correlated with a SAH diagnosis. Assessment of ONSD in head CTs taken with spontaneous SAH suspicion may be helpful in the diagnosis of spontaneous SAH.

Lochner P et al., (2019)[23] conducted research to elucidate both prevailing and novel applications of ONSD for neurologists and critical care physicians. They found that ONSD measurement is simple, easy to learn, and has diverse applications. ONSD has utility for ICP measurement in intracranial hemorrhage and ischemic stroke, meningitis and encephalitis, and idiopathic intracranial hypertension (IIH). It is also valuable for lesser-known syndromes, where an increase of ICP is postulated, such as acute mountain sickness and posterior reversible encephalopathy syndrome. ONSD changes develop in inflammatory or ischemic optic neuropathies. So, it was suggested that ONSD is a safe and low-cost bedside tool with the potential of screening patients who need other neuroimaging and those who may need an invasive measurement of ICP.

Naldi A et al., (2019)[25] evaluated the diagnostic accuracy of optic nerve sheath diameter (ONSD) and Doppler indices of central retinal arteries and veins for the detection of increased intracranial pressure (ICP) in intracerebral hemorrhage (ICH) and of the usefulness of a second assessment of these variables in the monitoring of ICH.A total of 46 acute ICH patients with (group 1, n = 25) and without (group 2, n = 21) clinical and radiological computed tomography signs of raised ICP and 40 healthy controls were recruited. The median binocular ONSD and Doppler indices of retinal vessels including resistive index (RI) and retinal venous pulsation (RVP) were compared among groups, both at admission and later during ICH monitoring.Median binocular ONSD showed higher accuracy for the detection of increased ICP (sensitivity and specificity 100%), while Doppler indices were less accurate (sensitivity 48% and specificity 95% for RI; 80% and 62% for RVP). In ICH patients, ONSD was significantly elevated in group 1 both at admission (6.40 mm [interquartile range [IQR] = .70] vs. 4.70 [.40]) and at control time (6.00 [.55] vs. 4.55 [.40]; P < .01), as well as RI (.79 [.11] vs. .77 [.03] and .80 [.06] vs. .75 [.35]; P = .01). RVP was significantly increased in group 1 only at admission (3.20 cm/s [1.05] vs. 2.00 [1.55], P = .02).Median binocular ONSD evaluation showed higher accuracy for the estimation of elevated ICP compared with

Doppler indices of retinal vessels. The ONSD enlargement detected in the early phase of ICH persists at control time.

Seyedhosseini J et al., (2019)[80] conducted a study to determine the relationship of ONSD in ocular US with prognosis in acute stroke in the emergency department (ED).Patients with acute presentations of stroke, presenting to the ED in 2017 (during six months), were enrolled in our study. US exam was performed on all of them and ONSD was determined in two longitudinal and transverse dimensions. Demographic data, rate of patients' admission in the ward or intensive care unit, one-month patients' outcome and type of stroke were recorded. The relationship of mean ONSD was evaluated with study variables. In this study, 60 patients were enrolled. The mean ± SD ONSD in the deceased cases was 4.40 ± 0.64 mm and in the survived patients was 3.83 ± 0.56 mm. Youden index calculated ONSD>3.9 mm as the best cut-off point in mortality prognosis. It has a sensitivity of 83.3% and a specificity of 59.2%. This study suggest that increased ONSD had a direct relationship with mortality rate in acute stroke.

Wang LG et al., (2020)[22] conducted study with aim to evaluate the clinical cases of the changes in ICP with venous sinus stenosis. ONSD and ICP were dynamically monitored as a lens for understanding the dynamic assessment for ICP. Two cases were studied: first case was of venous sinus stenosis with increased ICP recognized in real-time by changes in ONSD, which were correlated with ICP before and after stenting. Second case was of venous sinus thrombosis with increased ICP. Following treatment, the patient underwent an ultrasound ONSD examination and lumbar puncture (LP) at the 1st, 2nd, and 3rd month of follow-up. The previously enlarged ONSDs retracted and LP opening pressure gradually returned to normal. Findings of these cases indicated that ONSD examination may help to dynamically evaluate ICP changes and assess the efficacy of ICP treatment. These results provide utile, evidence based, preliminary clinical recommendations and indicate that ONSD examination may be a beneficial method of assessing ICP, particularly if repeated evaluations are required.

Stevens RRF et al., (2021)[81] performed a narrative review to identify discrepancies in ONSD assessment methodologies and to investigate their effect on reported ONSD values. They used a structured and quantitative approach in which each ONSD methodology found in the reviewed articles was categorized based on the characteristic appearance of the ultrasound images and ultrasound marker placement. Subsequently, investigated the influence of the different methodologies on ONSD values by organizing the ONSDs with respect to these categories. In a total of 63 eligible articles, they determined the applied ONSD assessment methodology. Reported ultrasound images either showed the optic nerve and its sheath as a dark region with hyperechoic striped band at its edges or as a single dark region surrounded by lighter retrobulbar fat. Four different ultrasound marker positions were used to delineate the optic nerve sheath, which resulted in different ONSD values and more importantly, different sensitivities to changes in ICP. Based on these observations, it was recommend to place ultrasound markers at the outer edges of the hyperechoic striped bands or at the transitions from the single dark region to the hyperechoic retrobulbar fat because these locations yielded the highest sensitivity of ONSD measurements for increased ICP.

Liu L et al., (2021)[82] investigated the role of eye-neck integrated ultrasound in the diagnosis and differentiation of idiopathic intracranial hypertension (IIH)and cerebral venous sinus thrombosis (CVST).Twenty IIH patients, 30 CVST patients, and 40 healthy controls were retrospectively analyzed. The ultrasonographic optic nerve sheath diameter (ONSD) and hemodynamic characteristics of the internal jugular veins (IJVs) were recorded. The cerebrospinal fluid opening pressure was measured after ultrasonic examination. The ONSD was significantly larger in IIH patients than in controls (4.71 ± 0.41 vs. 3.93 ± 0.24 mm, $p < 0.001$). The ONSD cut-off for IIH diagnosis was 4.25 mm (AUC = 0.978; 95% CI: 0.95–1.0, $p < 0.001$, sensitivity: 90%, specificity: 93%). In the CVST group, 22 (73.3%) patients had elevated intracranial pressure (ICP); the mean ONSD was significantly higher in patients with increased ICP than in those without (4.43 ± 0.33 vs. 3.95

± 0.17 mm, p < 0.001). The mean blood flow volume (BFV) was significantly reduced in CVST patients (425.17 ± 349.83 mL/min) compared to that in controls (680.37 ± 233.03 mL/min, p < 0.001) and IIH patients (617.67 ± 282.96 mL/min, p = 0.008). The optimal BFV cut-off for predicting CVST was 527.28 mL/min (AUC = 0.804, 95% CI: 0.68–0.93, p < 0.001, sensitivity: 80%, specificity: 78%). The velocity of the unilateral IJVs-J3 segment decreased or remained constant during deep inspiration (abnormal respiratory modulate blood flow test, ARMT) in 32.5% of controls, with no bilateral ARMT. The prevalence of bilateral ARMT was 25% in IIH patients ($\chi 2 = 12.9$, p = 0.005) and 27% in CVST patients ($\chi 2 = 17.6$, p = 0.001).Eye-neck integrated ultrasound is an easily available bedside technique to assess ICP and hemodynamic characteristics of IJVs. ONSD measurement can identify patients with increased ICP, and reduced IJV BFV may aid the differentiation of CVST and IIH.

Pansell J et al., (2022)[83] evaluated a protocol and compared two different measurement methods for ONSD ultrasound. Two operators, blinded to each other's measurements, measured ONSD, ED, and OND twice in 20 patients. ONSD was measured with two different methods in use: internal (ONSD int) or external (ONSD ext) of the dura mater. Intra-class correlation (ICC) was calculated for inter-rater and intra-rater reliability. ICCs for inter-rater reliability of ONSD ext and ONSD int (95% confidence interval) were 0.96 (0.93, 0.98) and 0.88 (0.79, 0.94), respectively. ICCs for intra-rater reliability of ONSD ext and ONSD int were 0.97 (0.94, 0.99) and 0.93 (0.87, 0.96), respectively. There was no significant bias or difference in intra-rater reliability between operators. This shows that ONSD can be measured with an excellent inter- and intra-rater reliability and low risk of inter-rater bias, when using this protocol. ONSD ext yields a higher inter- and intra-rater reliability than ONSD int. Corrections for ED and OND can be performed reliably.

Das SK et al., (2022)[84] performed a retrospective study to ascertain the role of optic nerve sheath diameter (ONSD) in the evaluation of cerebral venous sinus thrombosis (CVST). Forty-one patients across

all age groups with magnetic resonance venography (MRV) diagnosis of CVST and 82 gender-matched controls were included in the study. ONSD was measured on axial T2-weighted magnetic resonance images. CVST was identified on axial TOF-MRV including the stage, degree, and location. Intraparenchymal infarction and haemorrhage were also noted with their stage and size. The distribution of values for ONSD was tested for equality of variances using independent samples t-test. A cut-off value for ONSD was derived using ROC analysis. The mean difference between ONSD of cases and controls was 0.84 mm (95% CI: 0.61-1.06) and was statistically significant at $p < 0.001$. Mean ONSD in cases was 5.33 ± 0.66, and in the control group it was 4.49 ± 0.31. The cut-off value for ONSD was taken as 4.57 mm, derived using the ROC analysis (AUC was 0.876 suggesting good diagnostic accuracy). ONSD showed a sensitivity of 87% and a negative predictive value of 89% in predicting CVST. However, they found no statistical significance between ONSD in patients with acute or chronic thrombosis or in those with neuroparenchymal complications. They suggested that ONSD is a valid triage tool with high sensitivity and negative predictive value, and it can be used in the evaluation of CVST.

MATERIALS AND METHODS

The present study was conducted at Dayanand Medical College and Hospital, Ludhiana on patients who were diagnosed with CVT by CT scans in the neurology department.

SOURCE OF DATA

A Prospective Observational Cohort Study was conducted on all patient diagnosed with CVT; after determining the inclusion and exclusion criteria of the study, in the Department of Medical Emergency and Neurology of DMCH, Ludhiana over a period of 1 and half years from 1st March 2021 to 31st Aug 2022.

ETHICAL CLEARANCE AND CONFIDENTIALITY: The ethical clearance for study was taken by the Institutional Review Board for Ethical Clearance of Dayanand Medical College & Hospital, Ludhiana (Punjab). All subjects /attendants were explained about the procedure involved and purpose of the study. All consenting patients /attendants were asked to sign a written informed consent form (in the language best understood by them). The information regarding each patient was kept confidential and was not revealed at any point of time.

METHOD OF COLLECTION OF DATA

All patients diagnosed with CVT and willing to participate in the study after giving informed consent were included in the study.

Inclusion Criterion:

- Age more than 18 years
- Patients diagnosed with acute CVT
- Patients of either gender

Exclusion Criterion:

- Consent not available
- Age < 18 years
- Patient with traumatic brain injury
- Patients having orbital trauma
- Patient with Previous history of cranial injury
- Patients with history of glaucoma, amblyopia, or diseases of the optic nerve.

METHODOLOGY: A written informed consent was obtained from the patients who satisfied the eligibility criteria. After enrolment into the study, demographic and clinical history pertaining to age, gender and past medical history were obtained at the time of presentation. The patients were clinical examined for general physical assessment (vitals and BMI). The details regarding the presentation of symptoms were also be recorded on the pre-designed study proforma.

The patients were investigated with USG guided ONSD and ICP measurements. ONSD values were compared according to the time patient presented at the hospital.[78] Ultrasound examinations of the eye was carried out in B-mode by one experienced emergency physician/ resident.

Duration of Study / Number of Cases: 18 months from 1st March 2021 to 31st Aug 2022.

Outcome:

The patients were admitted and monitored for determining the overall length of hospital stay. During the period of stay, use of mechanical ventilation, and any adverse complications were recorded. The patients were followed till the day of discharge or death. Outcome of the patient included hospital stay and/or in-hospital mortality.

Statistical Analysis:

Data was described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. All statistical calculations was done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

OBSERVATION AND RESULTS

Table 1: Age distribution among study subjects

Age group	No. of cases	Percentage
≤ 30	11	32.4%
31-40	11	32.4%
41-50	8	23.5%
> 50	4	11.8%
Total	34	100.0%
Minimum	**Maximum**	**Mean±SD**
23yr	90yr	38.91±13.98

A Prospective Observational Cohort Study was conducted including 34 patients diagnosed with CVT, after considering the inclusion and exclusion criteria, in Department of Medical Emergency and Neurology, DMCH, Ludhiana. The written informed consent for clinical examination was obtained from patient/attendant. Of the 34 subjects included in the study, 11 (32.4%) subjects each were in age group ≤ 30 and 31-40 years. 8 (23.5%) subjects were between 41-50 years of age and 4 (11.8%) subjects were >50 years of age. The minimum age of the included subject was 23 years and maximum age was 90 years and the mean age of subjects was 38.91±13.98 years. (Table 1)

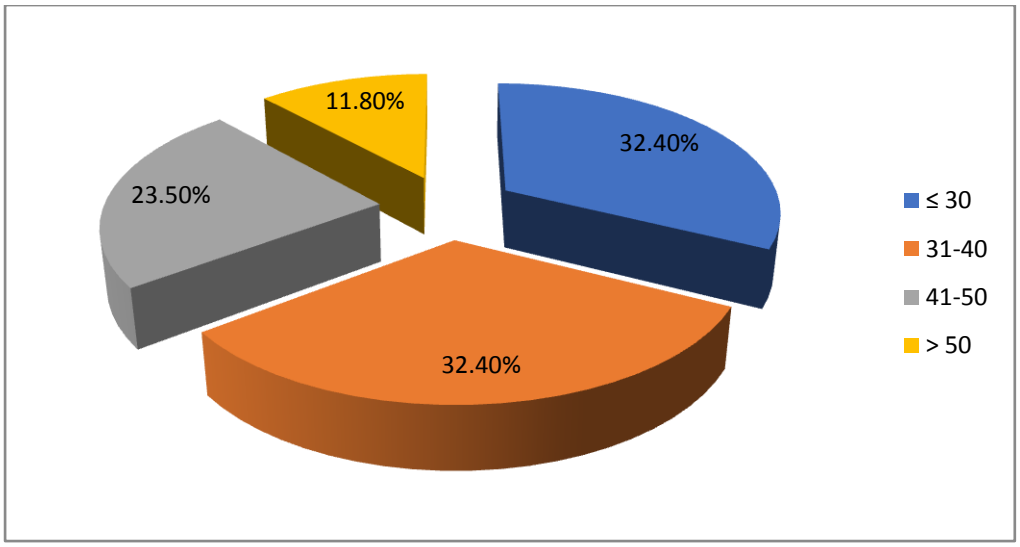


Figure 1: Age distribution among study subjects

Table 2: Gender distribution among study subjects

Gender	No. of cases	Percentage
F	14	41.2%
M	20	58.8%
Total	34	100.0%

In present study, majority of subjects were males (n=20, 58.8%) and 14 subjects were females (41.2%). (Table 2)

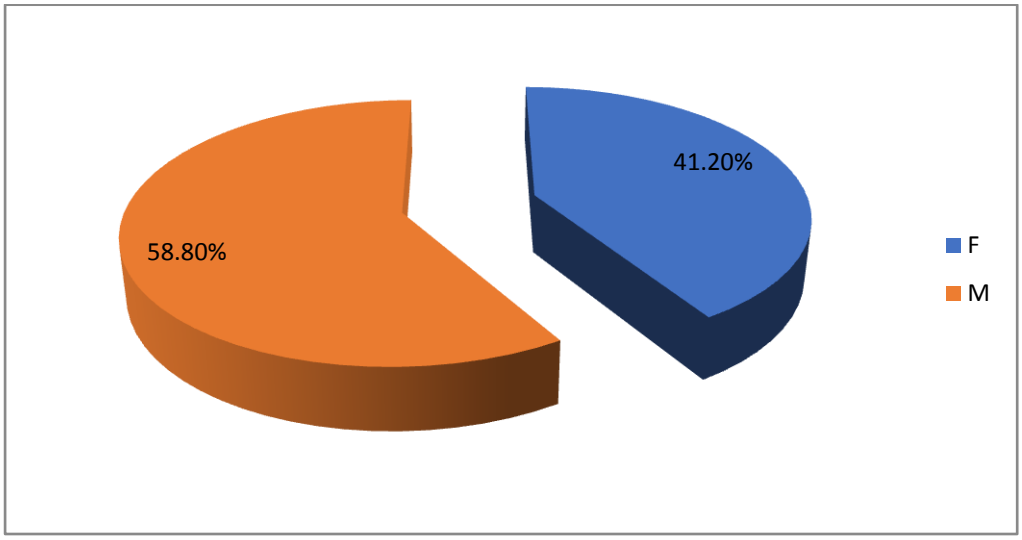


Figure 2: Gender distribution among study subjects

Table 3: Present neurological Illness among subjects

Present neurological Illness	No. of cases	Percentage
Features Of Intracranial Hypertension	31	91.2%
Headache	30	88.2%
Papilloedma	27	79.4%
Seizures	16	47.1%
6th Nerve Palsy	3	8.8%
Focal Syndrome Hemiparesis	15	44.1%
Cranial Nerve Deficit	7	20.6%
Aphasia	0	0.0%
Diffuse Encephalopathy Coma	3	8.8%

In present study, neurological illness present among subjects were Intracranial Hypertension (n=31,91.2%), Headache (n=30, 88.2%), Papilloedma (n=27, 79.4%), Seizures (n=16, 47.1%), 6th Nerve Palsy (n=3, 8.8%), Focal Syndrome Hemiparesis (n=15, 44.1%), Cranial Nerve Deficit (n=7, 20.6%), Diffuse Encephalopathy Coma (n=3, 8.8%) and no subject had aphasia. (Table 3)

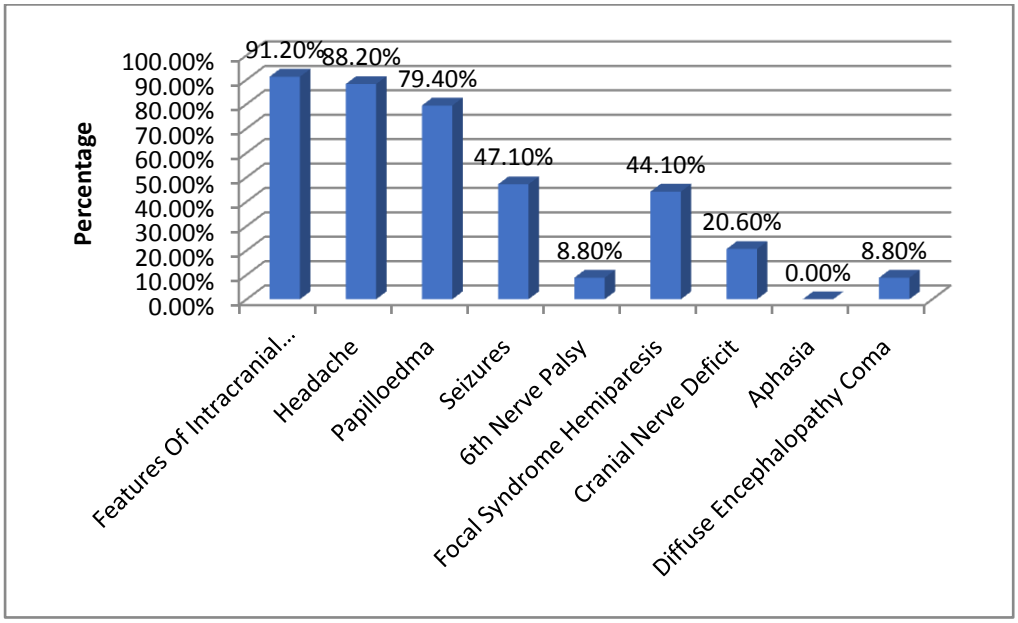


Figure 3: Present neurological Illness among subjects

Table 4: Past medical History of subjects

Past History	No. of cases	Percentage
Hypertension	4	11.8%
CAD	0	0.0%
Type 2 Diabetes Mellitus	2	5.9%

In present study, 4 (11.8%) subjects had history of hypertension, 2 (5.9%) complained of Type 2 Diabetes Mellitus and no subject had history of coronary artery disease. (Table 4)

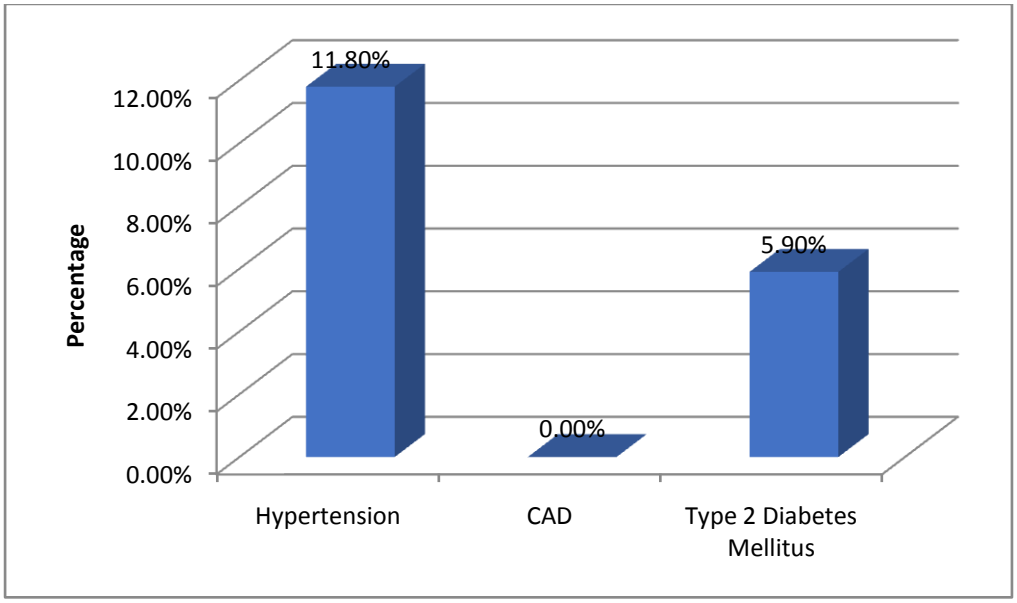


Figure 4: Past medical History of subjects

Table 5: Classification of severity of traumatic brain injury according to Glasgow Coma Scale (GCS)

GCS	No. of cases	Percentage
3-8 (Severe)	3	8.82%
9-12 (Moderate)	2	5.88%
13-15 (Mild)	29	85.29%
Total	34	100.0%
Minimum	**Maximum**	**Mean±SD**
6	15	13.88±2.50

In present study, 3 (8.82%) subjects had GCS score between 3-8 (Severe), 2 had GCS score between 9-12 (Moderate) and 29 had GCS score between 13-15 (Mild). The minimum GCS score was 6 and maximum was 15. The mean GCS score was 13.88±2.50. (Table 5)

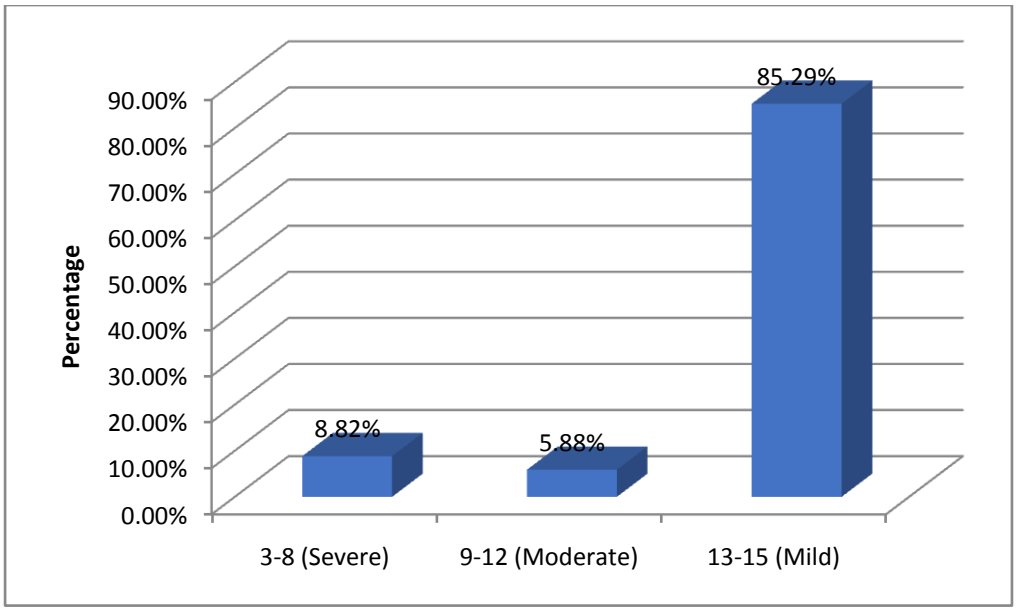


Figure 5: Classification of severity of traumatic brain injury according to Glasgow Coma Scale (GCS)

Table 6: Plantar Reflexes in subjects

Plantar Reflexes	No. of cases	Percentage
Extensor	11	32.4%
Flexor	22	64.7%
Mute	1	2.9%
Total	34	100.0%

In present study, plantar reflexes were noted in study subjects. 22 (64.7%) subjects had normal flexor response, 11 (32.4%) subjects had extensor response and in one subject (2.9%) it was mute. (Table 6)

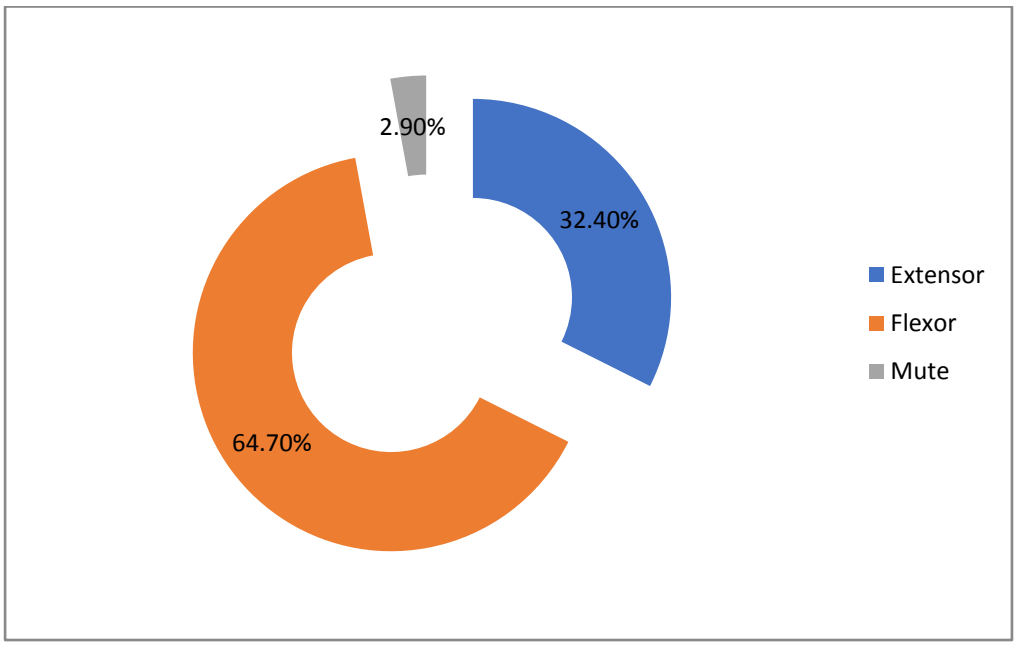


Figure 6: Plantar Reflexes in subjects

Table 7: Length of the hospital stay in subjects

Length of The Hospital Stay(in days)	No. of cases	Percentage
≤ 7	15	44.1%
8-14	15	44.1%
> 14	4	11.8%
Total	34	100.0%
Minimum	**Maximum**	**Mean±SD**
5 days	20 days	9.06±3.75

In present study, 15 (44.1%) subjects each were admitted in hospital for a duration of ≤ 7 and 8-14 days. 4 (11.8%) patients were admitted for >14 days. The minimum days of hospital stay was of 5 days and maximum was 20 days. The mean duration of hospital stay was of 9.06±3.75 days. (Table 7)

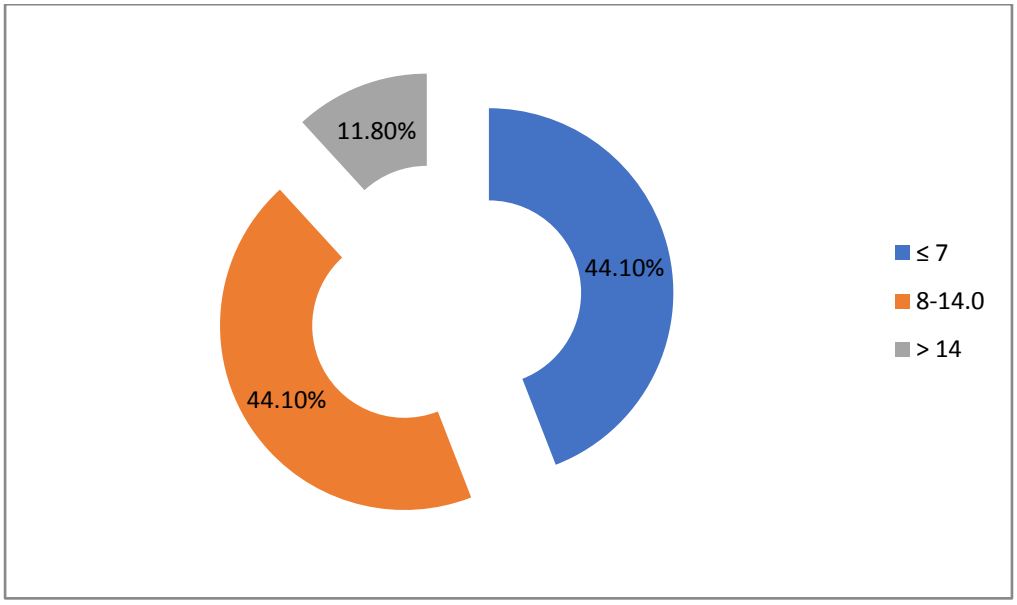


Figure 7: Length of the hospital stay in subjects

Table 8: Outcome of treatment

MORTALITY	No. of cases	Percentage
N	31	91.2%
Y	3	8.8%
Total	34	100.0%

In present study, of the 34 subjects, 3 (8.8%) subjects did not survive and 31 were saved. (Table 8)

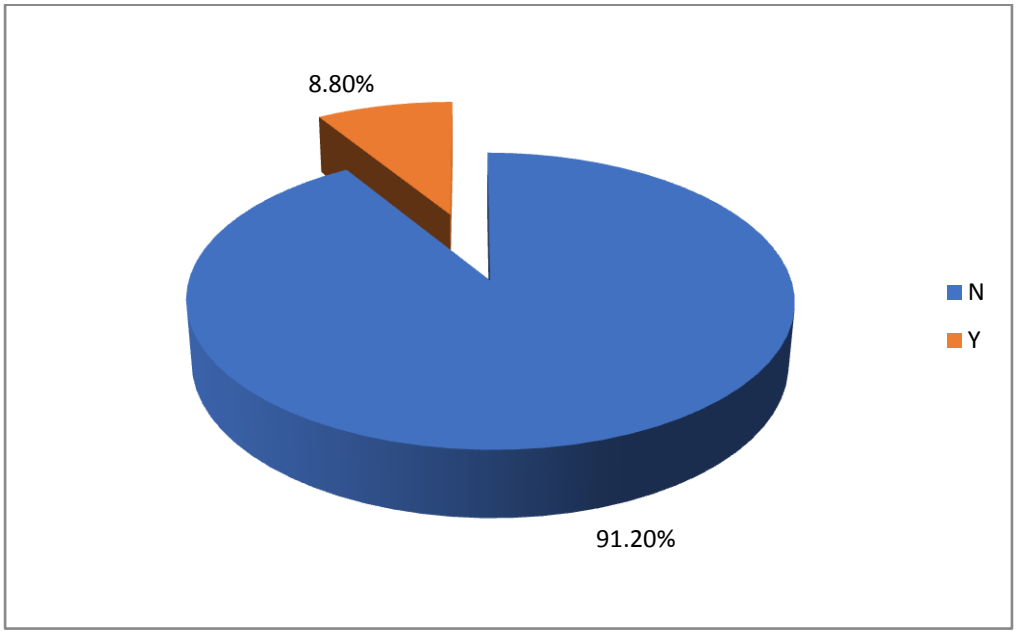


Figure 8: Outcome of treatment

Table 9: Distribution of subjects according to ICU admission requirement

ICU ADMISSION	No. of cases	Percentage
N	24	70.6%
Y	10	29.4%
Total	34	100.0%

In present study, among 34 subjects, 10 (29.4%) patients required ICU admission, whereas 24 (70.6%) subjects did not require it. (Table 9)

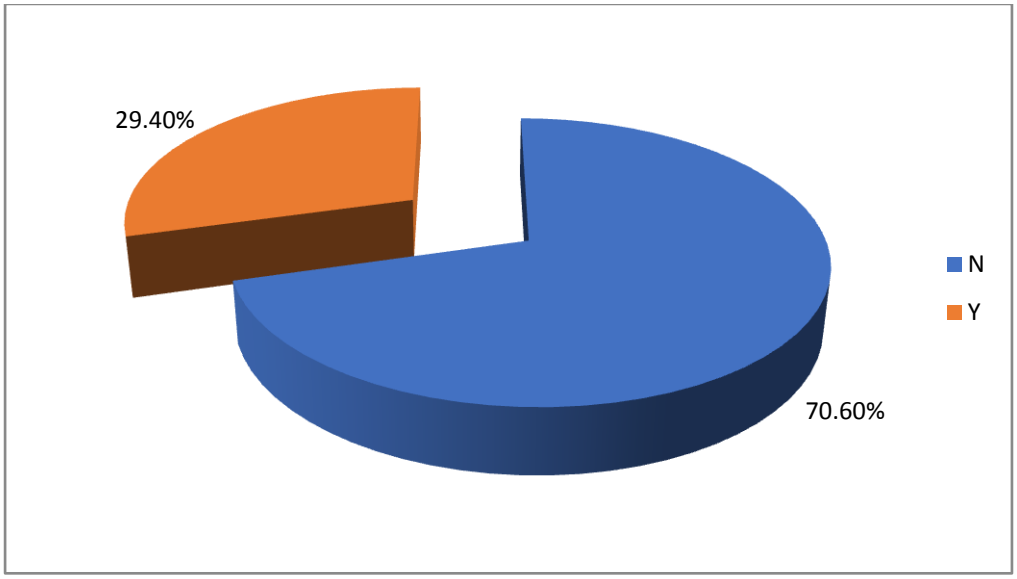


Figure 9: Distribution of subjects according to ICU admission requirement

Table 10: Distribution of subjects according to mechanical ventilation support requirement

Requirement of Mechanical Ventilation	No. of cases	Percentage
N	29	85.3%
Y	5	14.7%
Total	34	100.0%

Of the 34 subjects included in study, 5 (14.7%) patients required mechanical ventilation support, whereas 29 (85.3%)subjects did not require it. (Table 10)

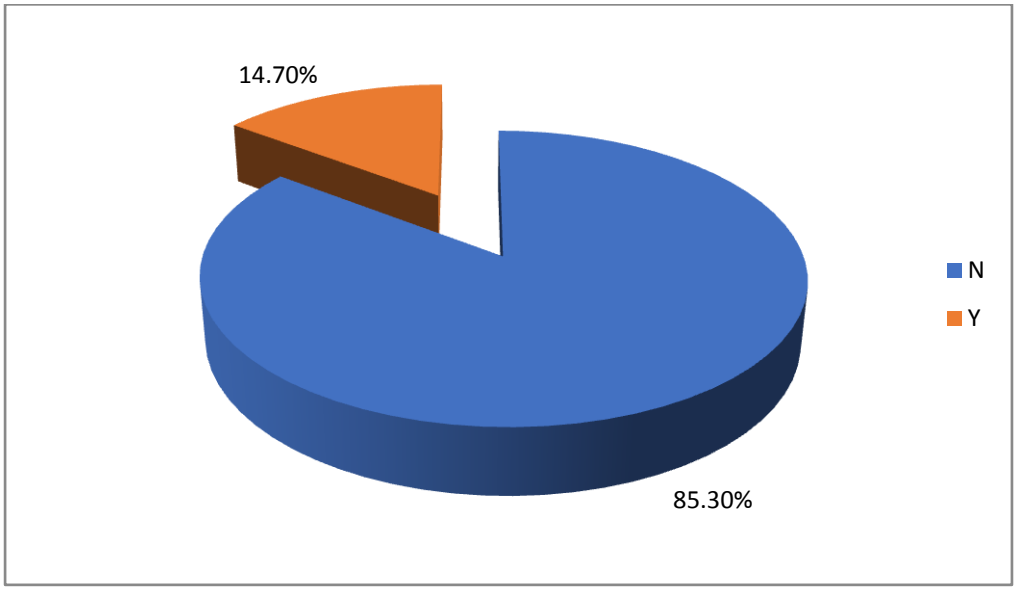


Figure 10: Distribution of subjects according to mechanical ventilation support requirement

Table 11: Distribution of subjects according to presence of any complication

COMPLICATIONS	No. of cases	Percentage
N	28	82.4%
Y	6	17.6%
Total	34	100.0%

Out of the 34 subjects, 6 (17.6%) subjects presented with complications and 28 (82.4%) others had no such problem. (Table 11)

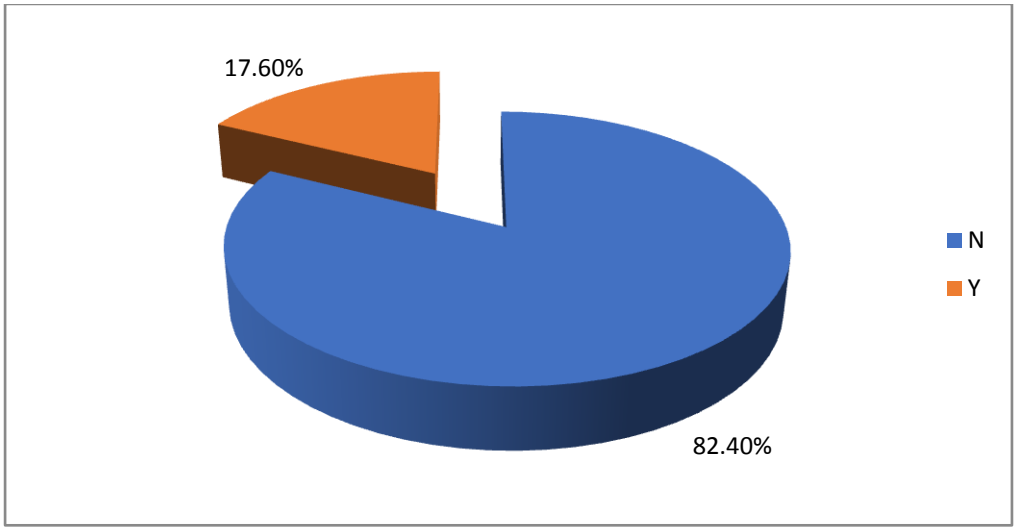


Figure 11: Distribution of subjects according to presence of any complication

Table 12: Distribution according to presence of disability in subjects

DISABILITY	No. of cases	Percentage
N	23	67.6%
Y	11	32.4%
Total	34	100.0%

In present study, 11 (32.4%) subjects had disability and 23 (67.6%) had no such complain. (Table 12)

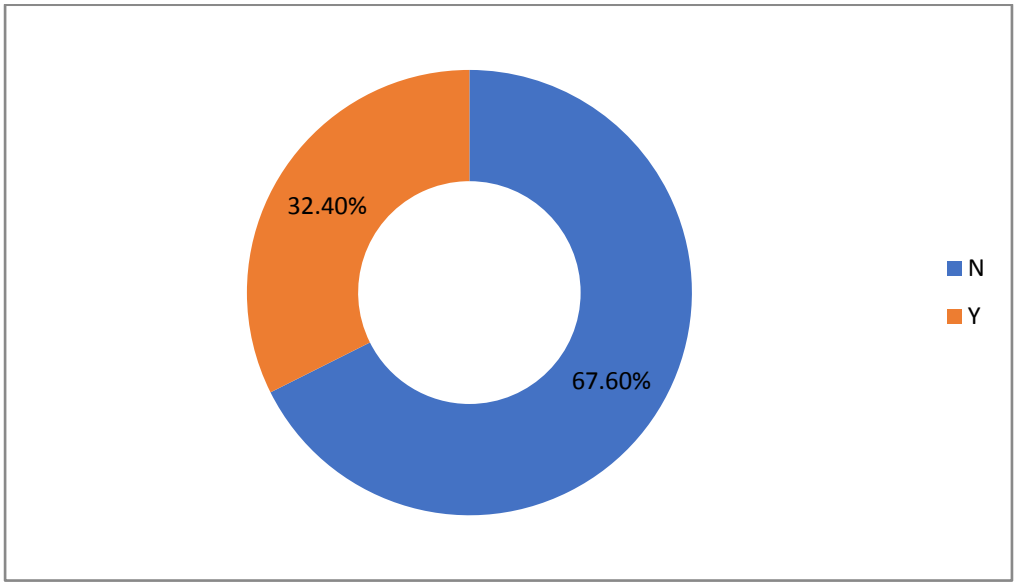


Figure 12: Distribution according to presence of disability in subjects

Table 13: Distribution of subjects according to discharge against medical advice (DAMA)

DAMA	No. of cases	Percentage
N	33	97.1%
Y	1	2.9%
Total	34	100.0%

Only one subject (2.9%) was discharge against medical advice. (Table 13)

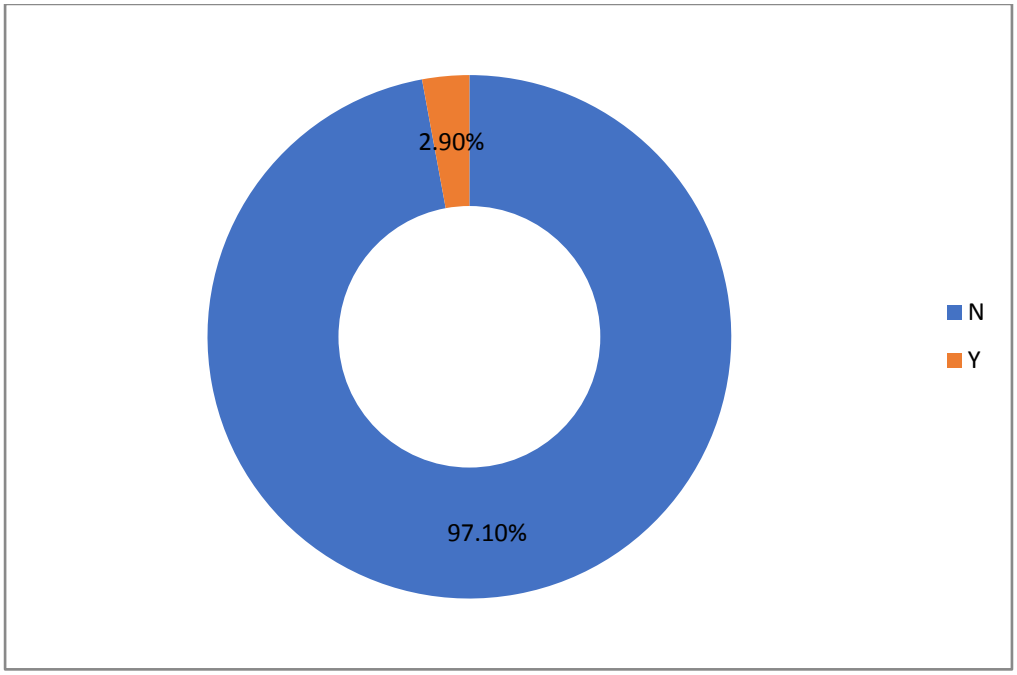


Figure 13: Distribution of subjects according to discharge against medical advice (DAMA)

Table 14: MRS score at time of admission

MRS SCORE	No. of cases	Percentage
GOOD (MRS < 0-≤2)	23	67.6%
BAD (MRS BETWEEN 3-5)	11	32.4%
Total	34	100.0%

In present study, 23 (67.6%) subjects had GOOD (MRS < 0-≤2) score and 11 (32.4%) had BAD (MRS BETWEEN 3-5) score. (Table 14)

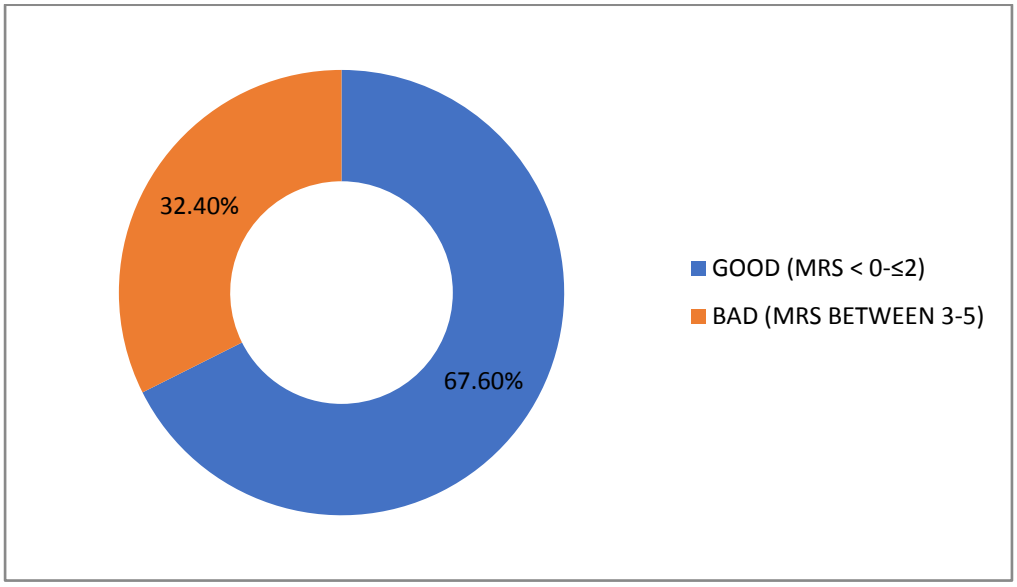


Figure 14: MRS score at time of admission

Table 15: Correlation between age and MRS score of subjects

		GOOD (MRS < 0-≤2)		BAD (MRS BETWEEN 3-5)		Total	Chi-square value	p-value
		No. of cases	Percentage	No. of cases	Percentage			
Age group	≤ 30	7	30.4%	4	36.4%	11	0.406	0.939
	31-40	8	34.8%	3	27.3%	11		
	41-50	5	21.7%	3	27.3%	8		
	> 50	3	13.0%	1	9.1%	4		
Total		23	100.0%	11	100.0%	34		

In present study, in age group ≤ 30 years 7 (30.4%) subjects had good MRS score and 4 (36.4%) had bad MRS score, in age range 31-40 years, 8 (34.8%) had good MRS score and 3 (27.3%) had bad MRS score, in 41-50 years age group, 5 (21.7%) had good MRS score and 3 (27.3%) had bad MRS score and in > 50 age group, 3 (13.0%) had good MRS score and 1 (9.1%) had bad MRS score. There was no significant difference present between category of MRS score and age group of the subjects. (Table 15)

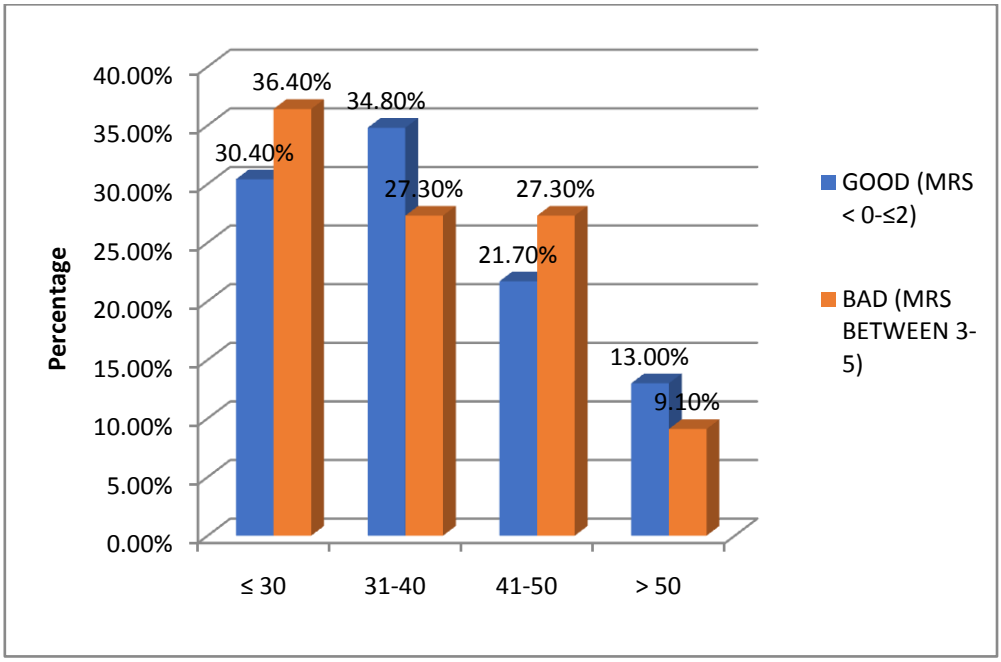


Figure 15: Correlation between age and MRS score of subjects

Table 16: Correlation between gender and MRS score of subjects

		GOOD (MRS < 0-≤2)		BAD (MRS BETWEEN 3-5)		Total	Chi-square value	p-value
		No. of cases	Percentage	No. of cases	Percentage			
Gender	F	10	43.5%	4	36.4%	14	0.156	0.693
	M	13	56.5%	7	63.6%	20		
Total		23	100.0%	11	100.0%	34		

In present study, among female subjects, 10 (43.5%) had good MRS score and 4 (36.4%) had bad MRS score. In male subjects, 13 (56.5%) had good MRS score and 7 (63.6%) had bad MRS score. There was no significant difference present between category of MRS score and gender of the subjects. (Table 16)

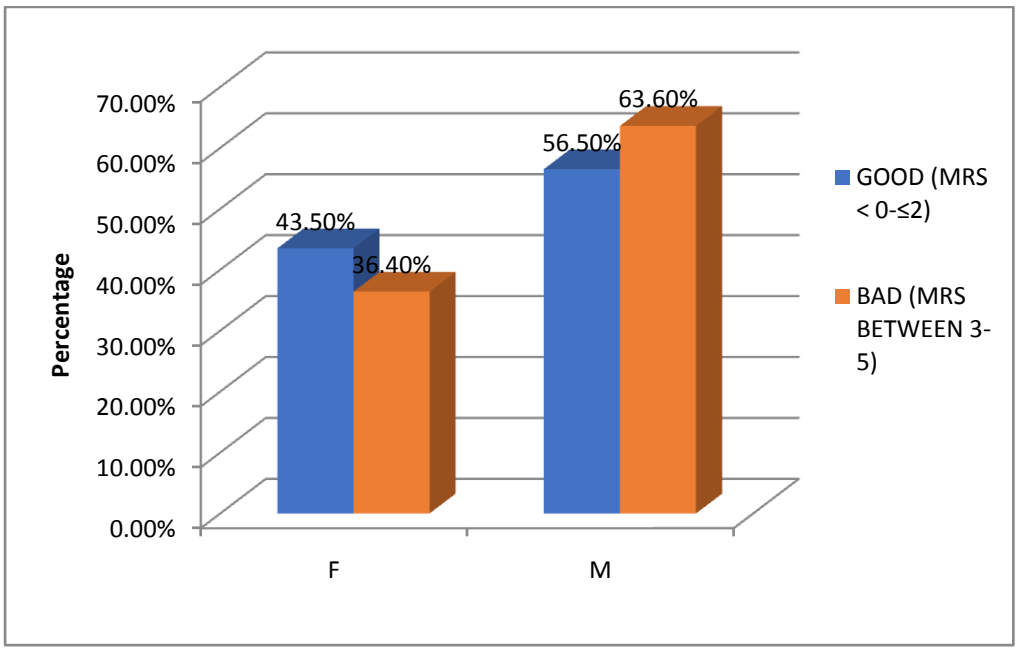


Figure 16: Correlation between gender and MRS score of subjects

Table 17: Correlation between neurological Illness and MRS score of subjects

		GOOD (MRS < 0-≤2)		BAD (MRS BETWEEN 3-5)		Total	Chi-square value	p-value
Present neurological Illness		No. of cases	Percentage	No. of cases	Percentage			
FEATURES OF INTRACRANIAL HYPERTENSION	N	1	4.3%	2	18.2%	3	1.770	0.239
	Y	22	95.7%	9	81.8%	31		
HEADACHE	N	2	8.7%	2	18.2%	4	0.645	0.580
	Y	21	91.3%	9	81.8%	30		
PAPILLOEDMA	N	5	21.7%	2	18.2%	7	0.058	0.810
	Y	18	78.3%	9	81.8%	27		
SEIZURES	N	14	60.9%	4	36.4%	18	1.794	0.274
	Y	9	39.1%	7	63.6%	16		
6th NERVE PALSY	N	21	91.3%	10	90.9%	31	0.001	0.970
	Y	2	8.7%	1	9.1%	3		
FOCAL SYNDROME HEMIPARESIS	N	15	65.2%	4	36.4%	19	2.513	0.151
	Y	8	34.8%	7	63.6%	15		
CRANIAL NERVE DEFICIT	N	20	87.0%	7	63.6%	27	2.475	0.178
	Y	3	13.0%	4	36.4%	7		
APHASIA	N	23	100.0%	11	100.0%	34		
DIFFUSE ENCEPHALOPATHY COMA	N	23	100.0%	8	72.7%	31	6.880	0.028*
	Y	0	0.0%	3	27.3%	3		

* : statistically significant

In present study, among 31 Intracranial Hypertension subjects 22 had good MRS score and 9 had bad MRS score but the difference was not significant. In 30 patients with complain of Headache 21 had good MRS score and 9 had bad MRS score, but it was not significant. Among 27 subjects with Papilloedma, 18 had good MRS score and 9 had bad score and the difference was not significant. In 16 Seizures subjects, 9 had good MRS score and 7 had bad MRS score, with no significant difference. Among 3 subjects with 6th Nerve Palsy 2 had good score and 1 had bad score showing no significant difference. In 15 subjects with Focal Syndrome Hemiparesis, 8 had good score and 7 had bad score showing no significant difference. In 7 Cranial Nerve Deficit subjects, 3 had good score and 4 had bad score, with no significant difference. There was a statistically significant difference present between category of MRS score and diffuse encephalopathy coma of the subjects, as all 3 subjects with diffuse encephalopathy coma had bad MRS score and no subject had good score (p=0.028). (Table 17)

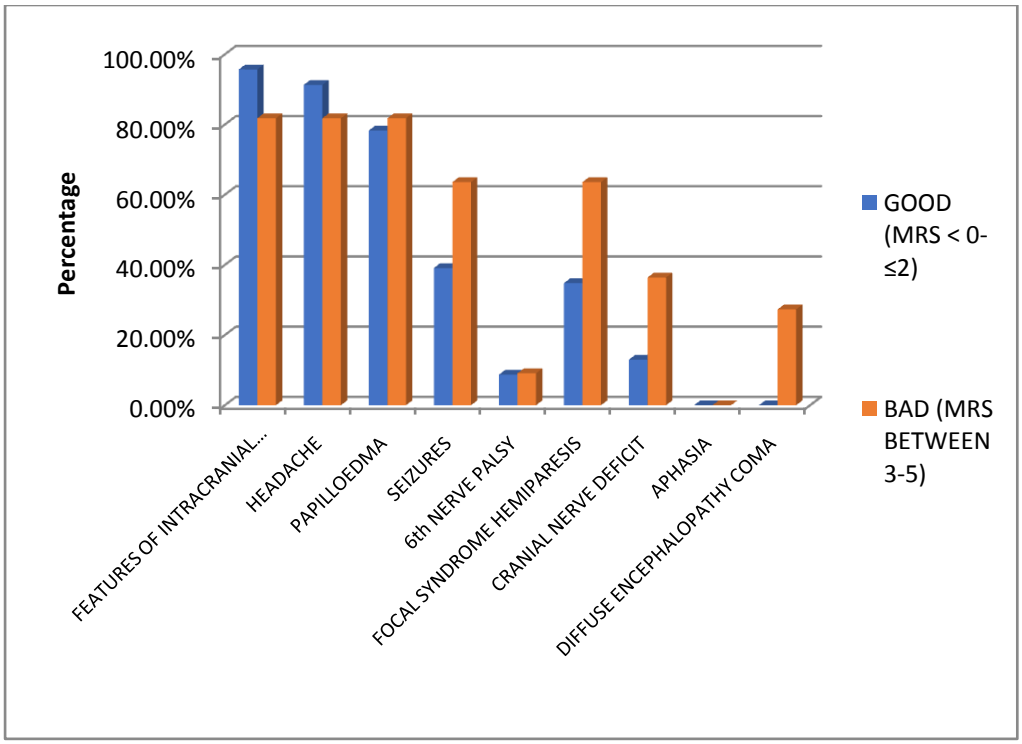


Figure 17: Correlation between neurological Illness and MRS score of subjects

Table 18: Correlation between GCS score and MRS score of subjects

		GOOD MRS		BAD MRS		Total	Chi-square value	p-value
		No. of cases	Percentage	No. of cases	Percentage			
GCS GROUP	3-8 (Severe)	0	0.0%	3	27.27%	3	6.81	0.032*
	9-12 (Moderate)	1	4.3%	1	9.09%	2		
	13-15 (Mild)	22	95.7%	7	63.6%	29		
Total		23	100.0%	11	100.0%	34		

* : statistically significant

In present study, 3-8 (Severe) GCS score group, all 3 subjects had bad MRS score, in 9-12 (Moderate)GCS score group, one subject each was in good and bad MRS score group and in 13-15 (Mild) GCS score group, 22 subjects had good MRS score and 7 subjects had bad MRS score, there was a statistically significant difference present between category of MRS score and GCS score severity (p= 0.032). (Table 18)

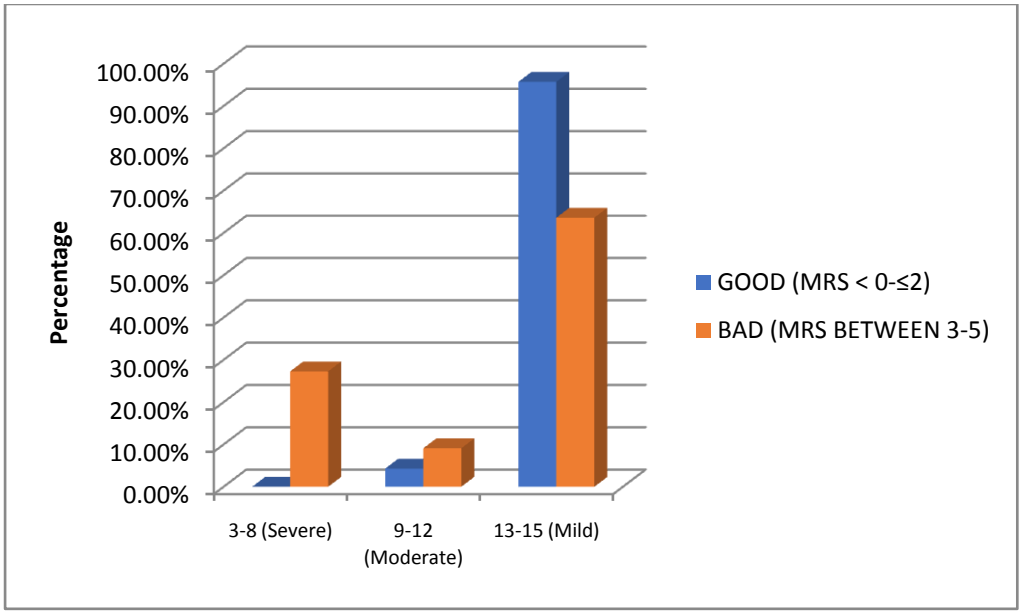


Figure 18: Correlation between GCS score and MRS score of subjects

Table 19: Correlation between mortality and MRS score of subjects

		GOOD (MRS < 0-≤2)		BAD (MRS BETWEEN 3-5)		Total	Chi-square value	p-value
		No. of cases	Percentage	No. of cases	Percentage			
MORTALITY	N	22	95.7%	9	81.8%	31	1.77	0.189
	Y	1	4.3%	2	18.2%	3		
Total		23	100.0%	11	100.0%	34		

In present study, one subject who did not survived had good MRS score and 2 subjects had bad score but there was no significant difference present between category of MRS score and mortality of the subjects.(Table 19)

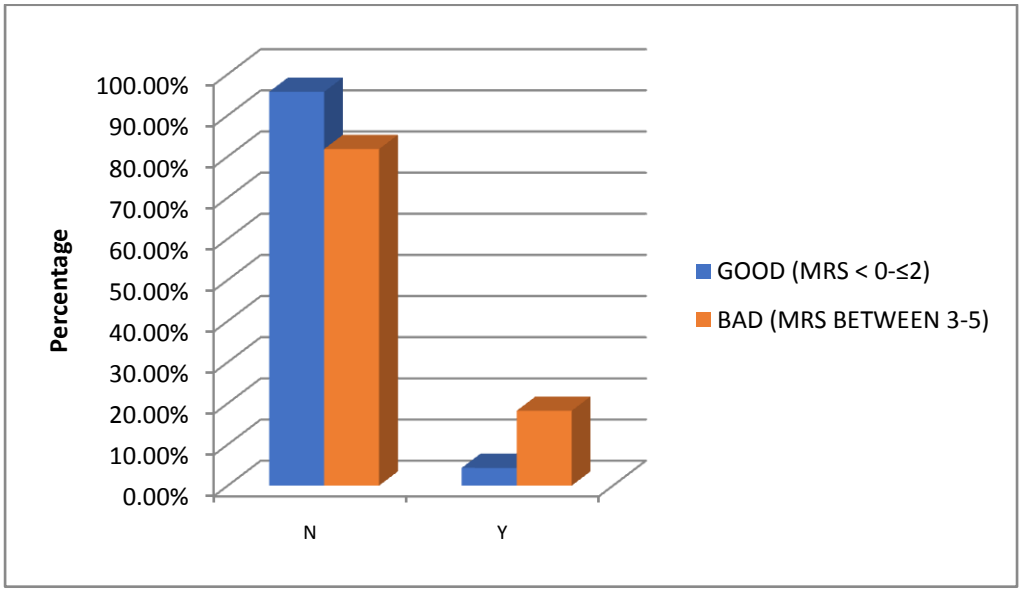


Figure 19: Correlation between mortality and MRS score of subjects

Table 20: Correlation between ICU admission and MRS score of subjects

		GOOD (MRS < 0-≤2)		BAD (MRS BETWEEN 3-5)		Total	Chi-square value	p-value
		No. of cases	Percentage	No. of cases	Percentage			
ICU ADMISSION	N	21	91.3%	3	27.3%	24	14.695	0.001*
	Y	2	8.7%	8	72.7%	10		
Total		23	100.0%	11	100.0%	34		

* : statistically significant

In present study, there was a statistically significant difference present between category of MRS score and ICU admission of subjects as among subjects who required ICU admission 8 (72.7%) had bad MRS score and only 2 (8.7%) had good score (p=0.001). (Table 20)

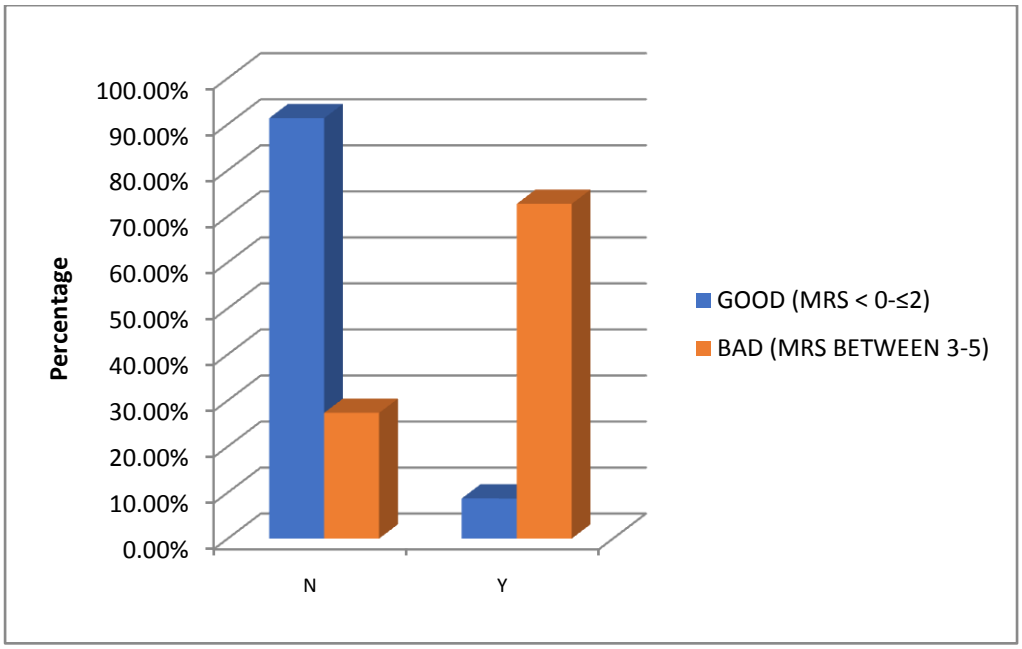


Figure 20: Correlation between ICU admission and MRS score of subjects

Table 21: Correlation between requirement of mechanical ventilation and MRS score of subjects

		GOOD (MRS < 0-≤2)		BAD (MRS BETWEEN 3-5)		Total	Chi-square value	p-value
		No. of cases	Percentage	No. of cases	Percentage			
REQUIREMENT OF MECHANICAL VENTILATION	N	22	95.7%	7	63.6%	29	6.081	0.029*
	Y	1	4.3%	4	36.4%	5		
Total		23	100.0%	11	100.0%	34		

* : statistically significant

In present study, there was a statistically significant difference present between category of MRS score and requirement of mechanical ventilation as among subjects who required mechanical ventilation support, 4 had bad MRS score and only one had good score (p=0.029). (Table 21)

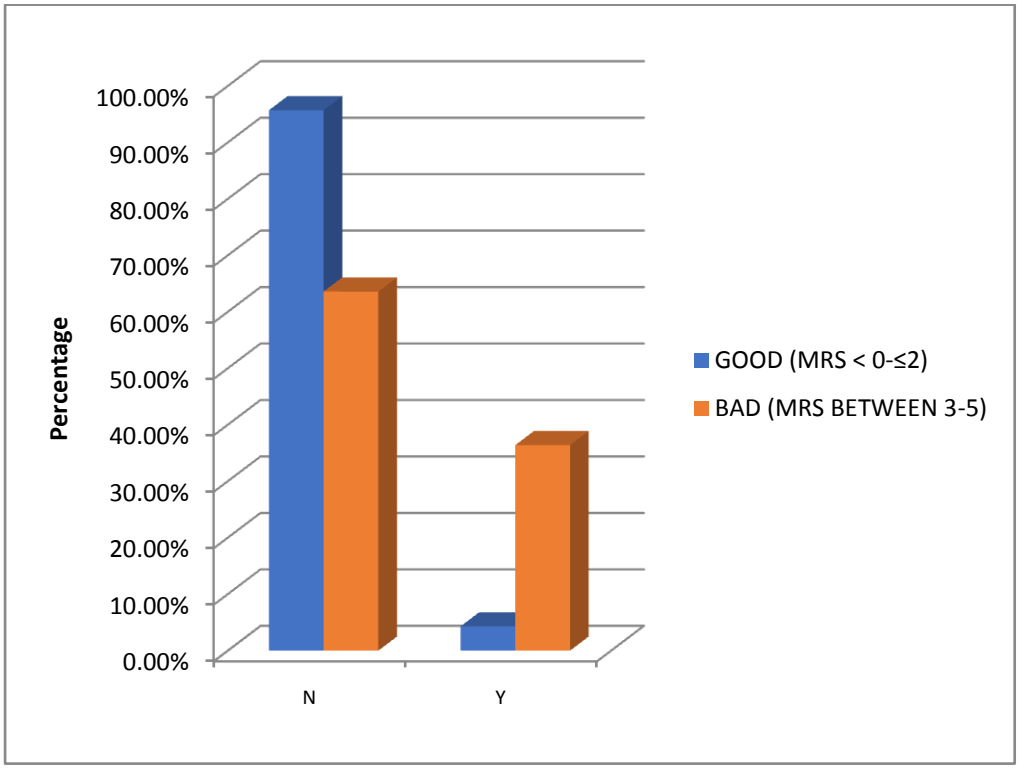


Figure 21: Correlation between requirement of mechanical ventilation and MRS score of subjects

Table 22: Correlation between disability and MRS score of subjects

		GOOD (MRS < 0-≤2)		BAD (MRS BETWEEN 3-5)		Total	Chi-square value	p-value
		No. of cases	Percentage	No. of cases	Percentage			
DISABILITY	N	21	91.3%	2	18.2%	23	18.179	0.001*
	Y	2	8.7%	9	81.8%	11		
Total		23	100.0%	11	100.0%	34		

* : statistically significant

In present study, there was a statistically significant difference present between category of MRS score and disability as among subjects who reported disability, 9 had bad MRS score and 2 had good score (p=0.001). (Table 22)

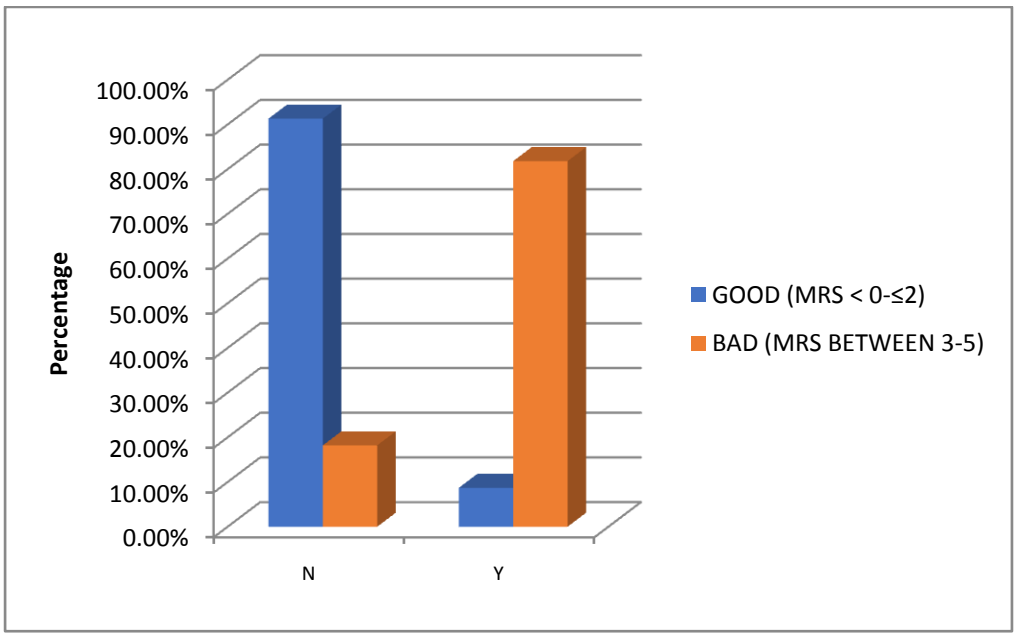


Figure 22: Correlation between disability and MRS score of subjects

Table 23: Correlation between length of the hospital stay and MRS score of subjects

	GOOD (MRS < 0-≤2)		BAD (MRS BETWEEN 3-5)		Z	p-value
	Mean	SD	Mean	SD		
LENGTH OF THE HOSPITAL STAY	9.00	3.85	9.18	3.71	0.130	0.897

In present study, the mean score of hospital stay in subjects with good MRS score was 9.00±3.85 and in subjects with bad score was 9.18±3.71. There was no significant difference present between category of MRS score and length of the hospital stay of the subjects. (Table 23)

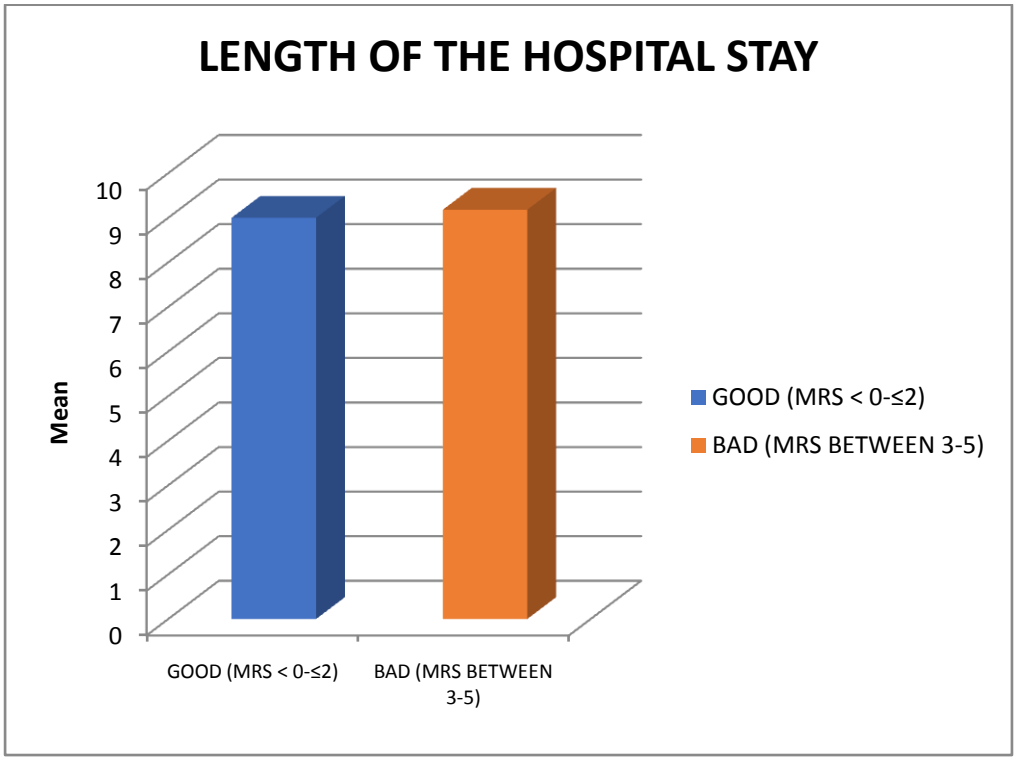


Figure 23: Correlation between length of the hospital stay and MRS score of subjects

Table 24: Descriptive analysis of ONSD

ONSD	Mean	SD
1st Day	4.95	0.35
4th Day	4.73	0.27
t test	4.56	
p value	<0.01*	

*: statistically significant

In present study, mean ONSD on 1st day of admission in hospital was 4.95±0.35 and on 4th day was 4.73±0.27, showing a statistically significant difference between the two values of ONSD (p<0.01). (Table 24)

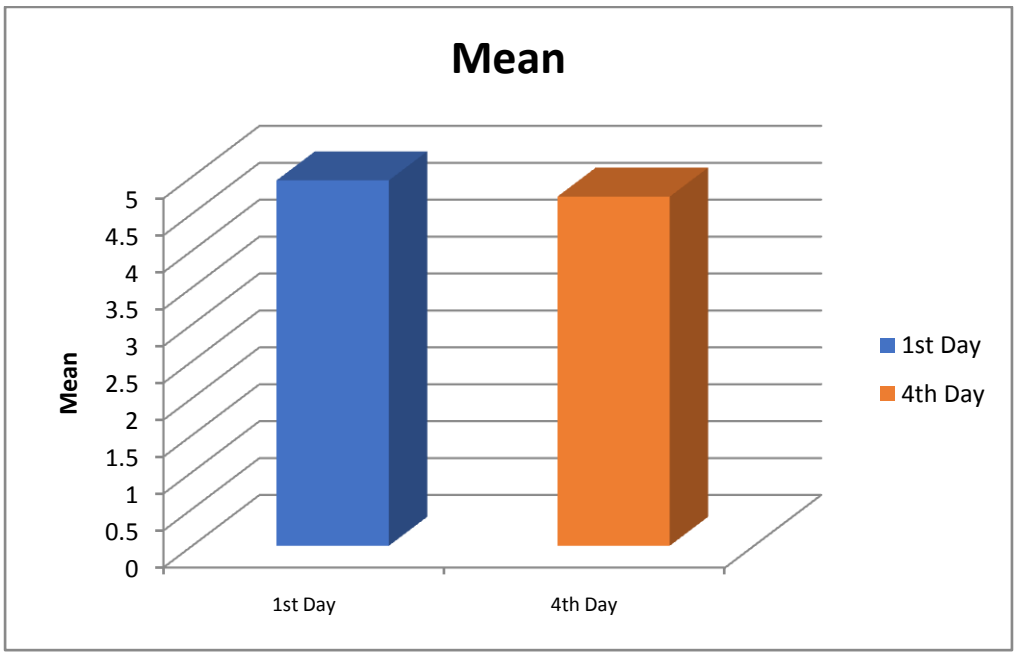


Figure 24: Descriptive analysis of ONSD

Table 25: Comparison of ONSD according to MRS status

MRS		ONSD	
		1st Day	4th Day
Bad	Mean	4.99	4.72
	SD	.48	.31
Good	Mean	4.94	4.73
	SD	.273	.26
t test		0.22	0.027
p value		0.64	0.87

In present study, the mean ONSD on 1st day of admission in hospital among subjects with bad MRS score was 4.99±0.48 and in subjects with good MRS score was 4.94±0.273, showing no significant difference. The mean ONSD on 4th day of admission in hospital among subjects with bad MRS score was 4.72±0.31 and in subjects with good MRS score was 4.73±0.26, showing no significant difference. (Table 25)

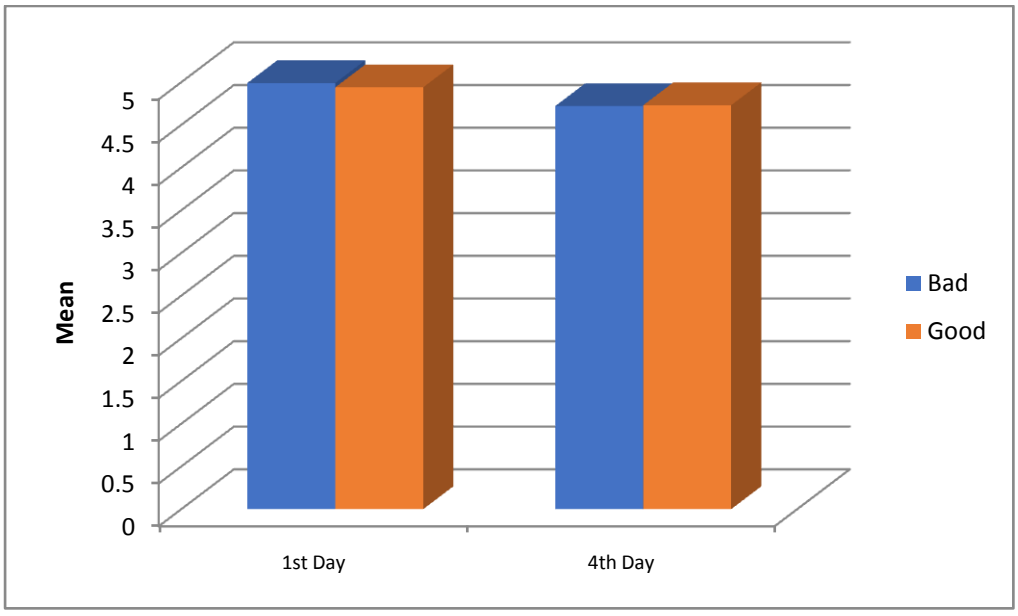


Figure 25: Comparison of ONSD according to MRS status

Table 26: Comparison of ONSD according to mortality

Mortality		ONSD	
		1st Day	4th Day
No	Mean	4.93	4.72
	SD	.36	.28
Yes	Mean	5.18	4.83
	SD	.076	.08
t test		2.45	2.41
p value		0.046*	0.048*

*: statistically significant

In present study, the mean ONSD on 1st day of admission in hospital among subjects with no mortality was 4.93±0.36 and in subjects with mortality was 5.18±0.76, showing a statistically significant difference between the two values (p=0.046). The mean ONSD on 4th day of admission in hospital among subjects with no mortality was 4.72±0.28 and in subjects with mortality was 4.83±0.08, showing a statistically significant difference between the two values (p=0.048). (Table 26)

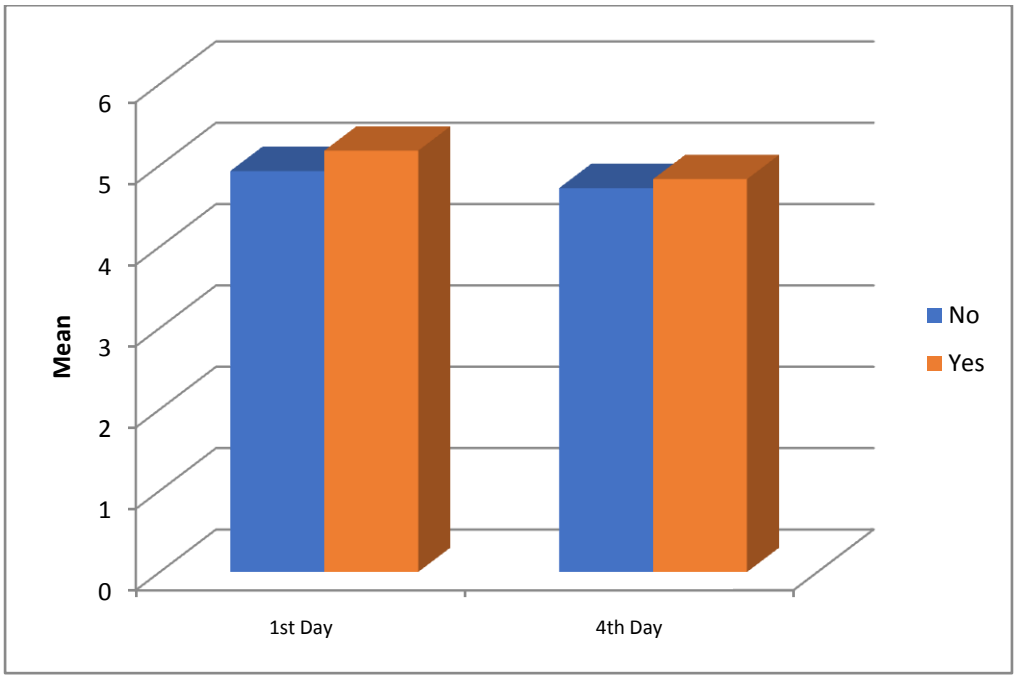


Figure 26: Comparison of ONSD according to mortality

Table 27: Diagnostic efficacy of ONSD (cut off: 4.8)

Variables	Value (%)
Sensitivity	81.50
Specificity	84.20
PPV	83
NPV	85.40

In present study, according diagnostic efficacy of ONSD (cut off: 4.8) Sensitivity was 81.50%, Specificity was 84.20%, PPV was 83% and NPV was 85.40%. (Table 27)

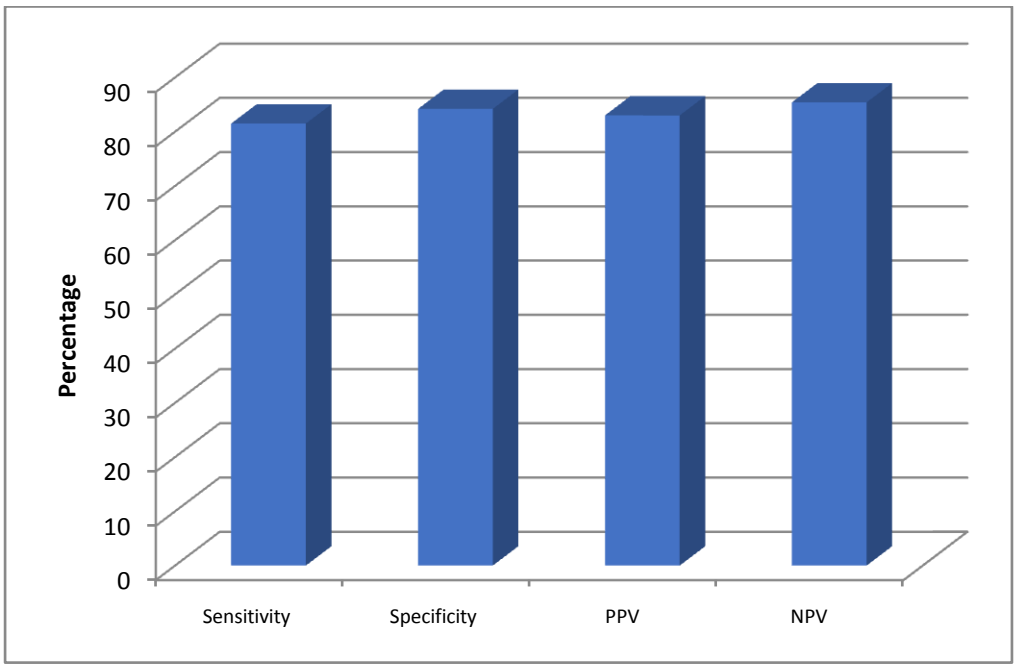


Figure 27: Diagnostic efficacy of ONSD (cut off: 4.8)

Table 28: Comparison of ONSD with mean age, duration of symptoms, GCS and length of hospital admission

ONSD	< 4.8 (n=12)		> 4.8 (n=22)		Z	p-value
	Mean	SD	Mean	SD		
Age	38.08	9.85	39.36	15.99	-0.252	0.803
DURATION OF SYMPTOM	6.42	2.94	3.09	2.41	3.561	0.001
GCS	14.33	2.02	13.64	2.74	0.773	0.445
LENGTH OF THE HOSPITAL STAY	7.92	2.97	9.68	4.04	-1.327	0.194

In present study, according to ONSD value <4.8, the mean age of subjects was 38.08±9.85 years and in ONSD > 4.8 group, mean age was 39.36±15.99 years but the difference was not significant. The mean duration of symptoms in ONSD value <4.8 group was 6.42±2.94 days and in ONSD > 4.8 group was 3.09±2.41 days, showing statistically significant difference between the two (p=0.001). The mean GCSin ONSD value <4.8 group was14.33±2.02and in ONSD > 4.8 group was13.64±2.74, but the difference between the two was not significant. The mean days of hospital admission in ONSD value <4.8 group was7.92±2.97 daysand in ONSD >4.8 group was9.68±4.04 days, showing the difference between the two but it was not significant. (Table 28)

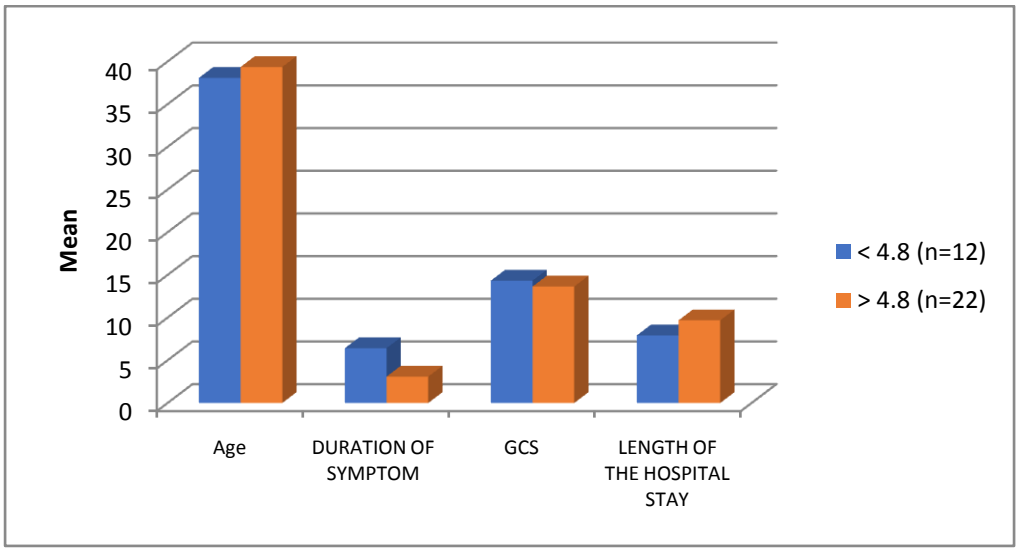


Figure 28: Comparison of ONSD with mean age, duration of symptoms, GCS and length of hospital admission

Table 29: Correlations of ONSD on 1st day and 4th day with age, duration of symptoms, MRS score, GCS and length of hospital admission

Spearman's rho		Age	DURATION OF SYMPTOM	mRS SCORE	GCS	LENGTH OF THE HOSPITAL STAY
ONSD 1ST DAY	Correlation Coefficient	0.087	-0.671	0.094	-0.077	0.002
	p-value	0.624	0.000	0.596	0.664	0.990
	N	34	34	34	34	34
ONSD 4 DAY	Correlation Coefficient	0.172	-0.494	-0.004	-0.011	0.100
	p-value	0.330	0.003	0.984	0.952	0.573
	N	34	34	34	34	34

In present study, on 1st day and 4th day ONSD value was positively correlated to age of subject but showing no significant difference. On1st day and 4th day ONSD value was negatively correlated with duration of symptoms and showing statistically significant difference. On 1st day and 4th day ONSD value had no statistically significant difference when correlated with mRS score, GCS score and length of hospital stay. (Table 29)

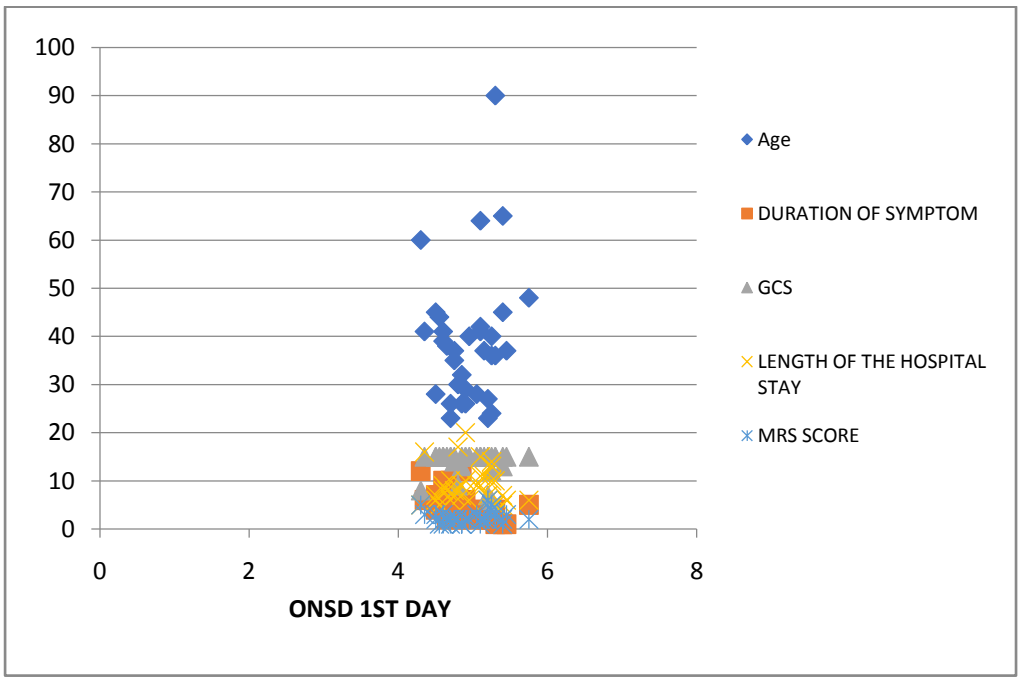


Figure 29A: Correlations of ONSD on 1st day with age, duration of symptoms, MRS score, GCS and length of hospital admission

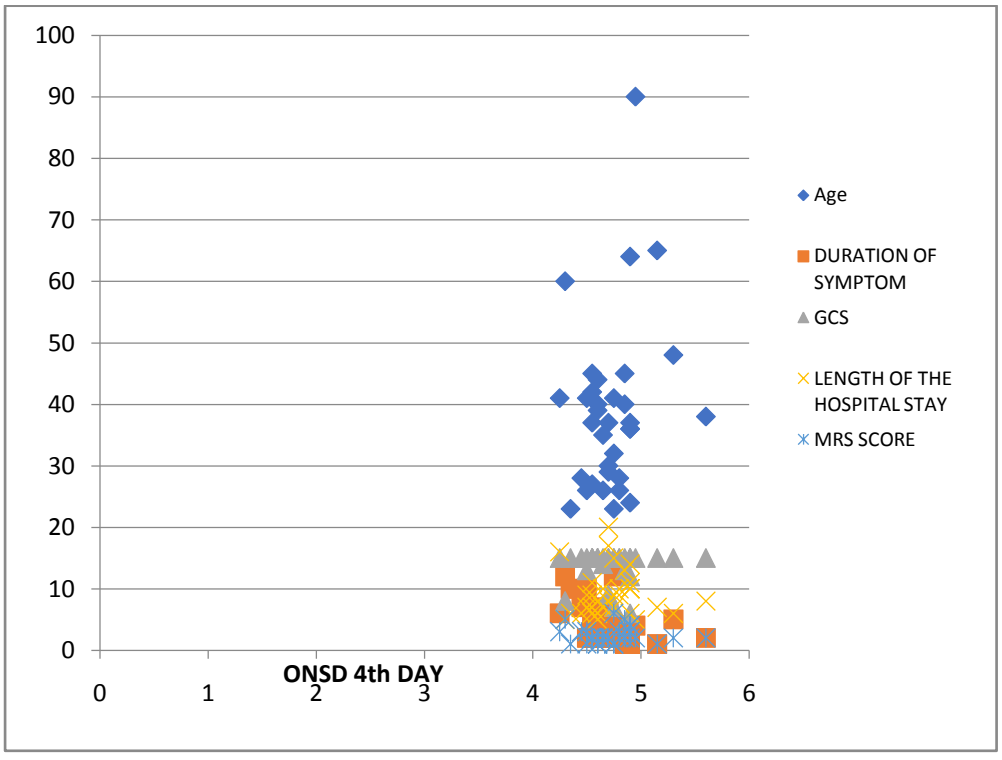


Figure 29B: Correlations of ONSD on 4th day with age, duration of symptoms, MRS score, GCS and length of hospital admission

DISCUSSION

CVST is an uncommon, potentially life-threatening condition that affects young adults, typically females < 40 years of age. The diagnosis can be challenging due to a wide range of clinical presentations that often mimic other neurological conditions. The clinical presentation depends on the onset, location, and size of the thrombus. A magnetic resonance venography (MRV) is not usually obtained during the initial workup when this diagnosis is not clinically suspected. A quick and precise diagnosis is, therefore, essential to decrease this risk. Estimation of intracranial pressure (ICP) may be helpful in the management of neurological critically ill patients. It has been shown that ultrasonography of the optic nerve sheath diameter (ONSD) is are liable tool for non-invasive estimation of increased intracranial pressure (ICP) at hospital admission or in intensive care. Less is known about the estimation of increased ICP and usefulness of ONSD. So, the present study was undertaken to determine the ONSD diameter changes in CVT patients and its association with short term outcomes. The knowledge of the changes in ONSD diameter with the occurrence of CVT may help in predicting the rise in ICP that may have implications in the management. The study results shall be helpful for better management of CVT subset of patients who present in the neurological settings.

The main findings of the present study are as follows:

Age distribution

Of the 34 subjects included in the study, 11 (32.4%) subjects each were in age group ≤ 30 and 31-40 years. 8 (23.5%) subjects were between 41-50 years of age and 4 (11.8%) subjects were >50 years of age. The minimum age of the included subject was 23 years, maximum age was 90 years and the mean age of subjects was 38.91±13.98 years.

According to the findings of **Pansell J et al., (2022)**,[83] mean age of the study subjects was 59±16 years.

In study done by **Liu L et al., (2021)**[82] the median age of subjects was 34years with an interquartile range of 18, a minimum age of 17, and a maximum of 72 years.

According to the results of **Seyedhosseini J et al., (2019),**[80] the mean age of subjects was 69.67 ± 13.23 years.

According to study done by **Das SK et al., (2022)**[84] the median age for the cases was 36 years with an interquartile range of 28, a minimum age of 18, and a maximum of 80 years.

Gender distribution

In present study, majority of subjects were males (n=20, 58.8%) and 14 subjects were females (41.2%).

In study done by **Das SK et al., (2022)**[84] they found that 56.1%(23/41) were males and 43.90% (18/41) were female subjects.

According to the findings of **Pansell J et al., (2022)**,[83] 55% (11/20) subjects were males and 45% (9/20) subjects were females.

According to the results of **Seyedhosseini J et al., (2019)**,[80] Males were 33 (55%) and Females were 27 (45%).

According to study done by **Liu L et al., (2021)**,[82] the males were 30% (9/30) and females were 70% (21/30).

Neurological illness

In present study, neurological illness present among subjects were Intracranial Hypertension (n=31,91.2%), Headache (n=30, 88.2%), Papilloedma (n=27, 79.4%), Seizures (n=16, 47.1%), 6th Nerve Palsy (n=3, 8.8%), Focal Syndrome Hemiparesis (n=15, 44.1%), Cranial Nerve Deficit (n=7, 20.6%), Diffuse Encephalopathy Coma (n=3, 8.8%) and no subject had aphasia.

In study done by **Das SK et al., (2022)**[84] they found that the most common clinical symptom was headache followed by altered consciousness.

According to the findings of **Pansell J et al., (2022)**,[83] 20 ICU admitted subjects were included in study of them, Subarachnoid hemorrhage was present in 4/20 subjects, Traumatic brain injury in 2/20 subjects and Intracrial hematoma in only one subject.

According to study done by **Liu L et al., (2021)**,[82] Papilledema was present in all 30 patients with idiopathic intracranial hypertension. In the CVST group, 22(73%) patients had elevated intracranial pressure.

Past medical history

In present study, 4 (11.8%) subjects had history of hypertension, 2 (5.9%) complained of Type 2 Diabetes Mellitus and no subject had history of coronary artery disease.

According to the findings of **Pansell J et al., (2022)**,[83] Comorbidities include cardiovascular disease (n= 3), Asthma/chronic obstructive pulmonary disease (n= 4) and Diabetes (n= 3).

According to study done by **Liu L et al., (2021)**,[82] comorbidities included Pregnancy or in puerperium (n = 8), Drugs (contraceptives, hormone replacement therapy) (n = 6), Prothrombotic conditions (n = 5), Autoimmune disease (n = 2), Cancer related (n = 1) and Hemopathy (n = 1).

Classification of severity of Neurological deficit according to GCS

In present study, 3 (8.82%) subjects had Glasgow Coma Scale (GCS) score between 3-8 suggestive of Severe brain injury, 2 had GCS score between 9-12 suggesting that they had Moderate brain injury and 29 had GCS score between 13-15 which means patients had Mild injury. The minimum GCS score was 6 and maximum was 15. The mean GCS score was 13.88±2.50.

Plantar reflexes

In present study, plantar reflexes were noted in study subjects. 22 (64.7%) subjects had normal flexor response, 11 (32.4%) subjects had abnormal extensor response suggestive of disease in brain and in one subject (2.9%) it was mute.

Duration of hospital admission

In present study, 15 (44.1%) subjects each were admitted in hospital for a duration of ≤ 7 and 8-14 days. 4 (11.8%) patients were admitted for >14 days. The minimum days of hospital stay was of 5 days and maximum was 20 days. The mean duration of hospital stay was of 9.06±3.75 days.

In study done by **Seyedhosseini J et al., (2019)**[80] the mean length of stay at hospital was4.73 ± 5.44 days.

Mortality

In present study, of the 34 subjects, 3 (8.8%) subjects did not survive and 31 were saved.

According to the results of **Seyedhosseini J et al., (2019)**,[80] 6 patients deceased during hospital admission time and 54 survived patients were finally discharged from the hospital and none of them deceased during one month after discharge.

In study done by **Canhão P et al., (2005)**,[4] twenty-seven patients (4.3%) died during the inclusion episode of CVT, 21(3.4%) within 30 days after symptom onset. None of these deaths occurred after discharge.

ICU admission

In present study, among 34 subjects, 10 (29.4%) patients required ICU admission, whereas 24 (70.6%) subjects did not require it.

In study done by **Seyedhosseini J et al., (2019),**[80] only one subject out of 60 included patients in study, required ICU admission.

Mechanical ventilation support requirement

Of the 34 subjects included in study, 5 (14.7%) patients required mechanical ventilation support, whereas 29 (85.3%) subjects did not require it.

Presence of complication

Out of the 34 subjects, 6 (17.6%) subjects presented with complications and 28 (82.4%) others had no such problem.

In study done by **Das SK et al., (2022)**[84] they found that, of the total41 cases, 17 (41%) were complicated by an intracranial haemorrhage, 11 had an acute bleed with an iso-hyperintensesignal on T1-WI, and 6 had a hypointense signal onT1-WI suggesting a chronic bleed.

Presence of disability

In present study, 11 (32.4%) subjects had disability and 23 (67.6%) had no such complain.

Descriptive analysis of ONSD

In present study, mean ONSD on 1st day of admission in hospital was 4.95±0.35 and on 4th day was 4.73±0.27, showing a statistically significant difference between the two values of ONSD (p<0.01).

In study done by **Seyedhosseini J et al., (2019)**[80] the mean ONSD was 3.89 ± 0.59 mm.

Gökcen E et al., (2017)[27] found that ONSD was significantly higher in the case group especially when the anterior circulation was involved (p<0.001).

According to the result of **Naldi A et al., (2019)**,[25] ONSD was significantly elevated in both at admission (6.40 mm [interquartile range [IQR] = .70] vs. 4.70[.40]) and at control time (6.00 [.55] vs. 4.55 [.40];P< .01).

In study done by **Das SK et al., (2022)**[84] they found that the mean ONSD ± SD for the right and the left eyes were 5.28 ± 0.71 mm and 5.38 ± 0.76 mm, respectively. The combined mean ONSD was 5.33 ± 0.66 mm in the cases and 4.49 ± 0.31 mm in the control group (p < 0.0001).

According to the findings of **Liu L et al., (2021),**[82] the mean ONSD was significantly larger in patients group than in controls (4.71 ± 0.41 vs. 3.93 ± 0.24mm, p < 0.001).

Diagnostic efficacy of ONSD

In present study, according diagnostic efficacy of ONSD Sensitivity was 81.50%, Specificity was 84.20%, PPV was 83% and NPV was 85.40%. The cut off value was 4.8mm. This was in line with other studies.

In study done by **Seyedhosseini J et al., (2019),**[80] they found that ONSD>3.9mm as the best cut-off point in mortality prognosis. It has a sensitivity of 83.3%, specificity of 59.2%, PPV 12.5% and NPV 95.0%.

In study done by **Das SK et al., (2022)**[84] they found that the cut-off value for ONSD derived from ROC analysis was 4.57 mm, which gave a sensitivity of 87.8% and a specificity of 53%.The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for this cut-off were 0.88, 0.53, 0.94, and 0.89, respectively.

According to the findings of **Liu L et al., (2021)**,[82] the ONSD cut-off was 4.25mm (AUC= 0.978; 95% CI: 0.95–1.0, p < 0.001) showing sensitivity of 90% and specificity was 93%.

According to the result of **Naldi A et al., (2019)**,[25] ONSD showed higher accuracy for the detection of increased ICP(sensitivity and specificity 100%).

Gökcen E et al., (2017)[27] found in their study that right ONSD had a significant predictive value in cerebrovascular diseases(AUC=0.941, p < 0.001). Optimal cut-off value was 5.4mm with75% sensitivity and 91% specificity. Left ONSD had also a significant predictive value (AUC=0.922, p < 0.001). Optimal cut-off value was5.3mm with 80% sensitivity and 84% specificity.

Comparison of ONSD with different variables

In present study, according to ONSD value <4.8, the mean age of subjects was 38.08±9.85 years and in ONSD > 4.8 group, mean age was 39.36±15.99 years but the difference was not significant, showing that age of the subject has no effect on the ONSD value. There was also no significant difference in to ONSD value according to gender of subject. The mean duration of symptoms in ONSD value <4.8 group was 6.42±2.94 days and in ONSD > 4.8 group was 3.09±2.41 days, showing statistically significant difference between the two (p=0.001), this suggest that when the ONSD value is more the duration of symptoms is less. The mean GCS in ONSD value <4.8 group was 14.33±2.02 and in ONSD > 4.8 group was 13.64±2.74, but the difference between the two was not significant. The mean days of hospital admission in ONSD value <4.8 group was 7.92±2.97 days and in ONSD >4.8 group was 9.68±4.04 days, showing the difference between the two, this shows that when ONSD value is more the length of hospital stay increases but it was not statistically significant.

Correlations of ONSD on 1st day and 4th day with age, duration of symptoms, mRS score, GCS and length of hospital admission

In present study, on 1st day and 4th day ONSD value was positively correlated to age of subject but showing no significant difference. On 1st day and 4th day ONSD value was negatively correlated with duration

of symptoms and showing statistically significant difference, this suggest that when the value of ONSD is more than duration of symptoms will be less. On 1st day and 4th day ONSD value had no statistically significant difference when correlated with mRS score, GCS score and length of hospital stay.

According to the findings of **Liu L et al., (2021),**[82] there were no correlations between the ONSD and age and gender of subject.

Comparison of ONSD according to mortality

In present study, the mean ONSD on 1st day of admission in hospital among subjects with no mortality was 4.93±0.36 and in subjects with mortality was 5.18±0.76, showing a statistically significant difference between the two values (p=0.046). The mean ONSD on 4th day of admission in hospital among subjects with no mortality was 4.72±0.28 and in subjects with mortality was 4.83±0.08, showing a statistically significant difference between the two values (p=0.048). This suggest that increased ONSD had a direct relationship with mortality rate.

In study done by **Seyedhosseini J et al., (2019)**[80] the mean ± SD ONSD in the deceased cases was4.40 ± 0.64mm and in the survived patients was 3.83 ± 0.56 mm, showing a statistically significant difference (p=0.036).

Henda VS et al., (2015)[85] determined a significant difference in ONSD between the deceased and survived groups. They reported that each 0.1 cm increase in ONSD increased the mortality rate 4.2 and 6.2 times in ischemic and hemorrhagic stroke respectively.

MRS score at time of admission

In present study, 23 (67.6%) subjects had GOOD (MRS < 0-≤2) score and 11 (32.4%) had BAD (MRS BETWEEN 3-5) score.

Correlation of category of MRS score with other variables

In present study, in age group ≤ 30 years 7 (30.4%) subjects had good MRS score and 4 (36.4%) had bad MRS score, in age range 31-40 years, 8 (34.8%) had good MRS score and 3 (27.3%) had bad MRS score, in 41-50 years age group, 5 (21.7%) had good MRS score and 3 (27.3%) had bad MRS score and in > 50 age group, 3 (13.0%) had good MRS score and 1 (9.1%) had bad MRS score. There was no

significant difference present between category of MRS score and age group of the subjects.

In present study, among female subjects, 10 (43.5%) had good MRS score and 4 (36.4%) had bad MRS score. In male subjects, 13 (56.5%) had good MRS score and 7 (63.6%) had bad MRS score. There was no significant difference present between category of MRS score and gender of the subjects.

In present study, among 31 Intracranial Hypertension subjects 22 had good MRS score and 9 had bad MRS score but the difference was not significant. In 30 patients with complain of Headache 21 had good MRS score and 9 had bad MRS score, but it was not significant. Among 27 subjects with Papilloedma, 18 had good MRS score and 9 had bad score and the difference was not significant. In 16 Seizures subjects, 9 had good MRS score and 7 had bad MRS score, with no significant difference. Among 3 subjects with 6th Nerve Palsy 2 had good score and 1 had bad score showing no significant difference. In 15 subjects with Focal Syndrome Hemiparesis, 8 had good score and 7 had bad score showing no significant difference. In 7 Cranial Nerve Deficit subjects, 3 had good score and 4 had bad score, with no significant difference. There was a statistically significant difference present between category of MRS score and diffuse encephalopathy coma of the subjects, as all 3 subjects with diffuse encephalopathy coma had bad MRS score and no subject had good score (p=0.028).

In study done by **Canhão P et al., (2005)**,[4] mental status disorders (P<0.001), impaired consciousness (P<0.001), and seizures (P=0.002) at admission were more frequent in patients who died, whereas isolated intracranial hypertension syndrome was less frequent (P=0.023). Thrombosis of the superior sagittal sinus (P=0.023), cortical veins (P=0.004), deep cerebral veins (P<0.001), parenchymal lesions (P=0.002), hemorrhagic lesions (P=0.002), right hemorrhagic lesions (P=0.001), and posterior fossa lesion (P=0.004) were more frequent at admission in patients who died. Size of parenchymal lesions was significantly higher in patients who died during the acute phase. Twelve of 25 (48%) had parenchymal lesions >5 cm in their larger diameter, in

contrast to 106 of 558 surviving patients (19%; OR, 3.9; 95% CI, 1.8 to 8.9; P0.001).

In present study, 3-8 (Severe) GCS score group, all 3 subjects had bad MRS score, in 9-12 (Moderate) GCS score group, one subject each was in good and bad MRS score group and in 13-15 (Mild) GCS score group, 22 subjects had good MRS score and 7 subjects had bad MRS score, there was a statistically significant difference present between category of MRS score and GCS score severity (p= 0.032).

In present study, one subject who did not survived had good MRS score and 2 subjects had bad score but there was no significant difference present between category of MRS score and mortality of the subjects.

In present study, there was a statistically significant difference present between category of MRS score and ICU admission of subjects as among subjects who required ICU admission 8 had bad MRS score and only 2 had good score (p=0.001).

In present study, there was a statistically significant difference present between category of MRS score and requirement of mechanical ventilation as among subjects who required mechanical ventilation support, 4 had bad MRS score and only one had good score (p=0.029).

In present study, there was a statistically significant difference present between category of MRS score and disability as among subjects who reported disability, 9 had bad MRS score and 2 had good score (p=0.001).

In present study, the mean score of hospital stay in subjects with good MRS score was 9.00±3.85 and in subjects with bad score was 9.18±3.71. There was no significant difference present between category of MRS score and length of the hospital stay of the subjects.

Comparison of ONSD according to MRS status

In present study, the mean ONSD on 1st day of admission in hospital among subjects with bad MRS score was 4.99±0.48 and in subjects with good MRS score was 4.94±0.273, showing no significant difference. The mean ONSD on 4th day of admission in hospital among

subjects with bad MRS score was 4.72±0.31 and in subjects with good MRS score was 4.73±0.26, showing no significant difference.

LIMITATION

The shortcomings of the present study included the small sample size and that the patients included were from single center, so further studies are required including larger group of subjects from multiple hospitals to validate findings of present study. The ONSD is an observer dependant finding hence this will always be a limiting factor which will depend upon physician performing ONSD.

SUMMARY AND CONCLUSION

The present Prospective Observational Cohort study was conducted in the Department of Medical Emergency and Neurology, DMCH, Ludhiana, after approval of the research review board, including 34 patients diagnosed with CVT, after considering the inclusion and exclusion criteria. The study protocol for all procedures was approved by the Institutional Review Board for Ethical Clearance of Dayanand Medical College & Hospital, Ludhiana. All subject/ attendants were explained about the study and were asked to sign a written consent prior to commencement of the study. The information regarding each patient was kept confidential and was not revealed at any point of time. After enrolment into the study, demographic and clinical history pertaining to age, gender and past medical history were obtained at the time of presentation. The details regarding the presentation of symptoms were also be recorded on the pre-designed study proforma. The patients were investigated with USG guided ONSD and ICP measurements.

- Following are the main inferences of the present research work:
- The minimum age of the included subject was 23 years, maximum age was 90 years and the mean age of subjects was 38.91±13.98 years.
- Majority of subjects were males (58.8%).
- Subjects which had Intracranial Hypertension (n=31, 91.2%) followed by Headache (n=30, 88.2%) were as the two most common presenting neurological features.
- Three (8.82%) subjects had GCS score between 3-8 (Severe), 2 had GCS score between 9-12 (Moderate) and 29 had GCS score between 13-15 (Mild).
- Eleven (32.4%) subjects had extensor response suggesting intracranial involvement.
- Fifteen (44.1%) subjects each were admitted in hospital for a duration of ≤ 7 and 8-14 days. 4 (11.8%) patients were admitted for >14 days.

- Three (8.8%) subjects did not survive.
- On the other hand, Ten (29.4%) patients required ICU admission their illness.
- Five (14.7%) patients required mechanical ventilation support.
- Six (17.6%) subjects had complications during their stay in hospital.
- Eleven (32.4%) subjects had disability.
- Twenty three (67.6%) subjects had GOOD (MRS < 0-≤2) score and 11 (32.4%) had BAD (MRS BETWEEN 3-5) score.
- According diagnostic efficacy of ONSD (cut off: 4.8) Sensitivity was 81.50%, Specificity was 84.20%, PPV was 83% and NPV was 85.40%.
- The mean duration of symptoms in ONSD value <4.8 group was 6.42±2.94 days and in ONSD > 4.8 group was 3.09±2.41 days, showing statistically significant difference between the two (p=0.001). But there was no significant difference in ONSD value according to age, gender, GCS and duration of hospital admission.
- ONSD value on 1^{st} day and 4^{th} day was negatively correlated with duration of symptoms and showing statistically significant difference. But there was no significant correlation of age, mRS score, GCS score and length of hospital stay with ONSD value.
- Mean ONSD on 1^{st} day of admission in hospital was 4.95±0.35 and on 4^{th} day was 4.73±0.27, showing a statistically significant difference between the two values of ONSD (p<0.01).
- Comparison of ONSD according to MRS status showed no significant difference.
- The mean ONSD on 1^{st} day of admission in hospital among subjects with no mortality was 4.93±0.36 and in subjects with mortality was 5.18±0.76, showing a statistically significant difference between the two values (p=0.046). The mean ONSD on 4^{th} day of admission in hospital among subjects with no mortality was 4.72±0.28 and in subjects with mortality was

4.83±0.08, showing a statistically significant difference between the two values (p=0.048).

- There was no significant difference present between category of MRS score when compared with age group, gender, length of the hospital admission and mortality of the subjects.
- There was a statistically significant difference present between category of MRS score and diffuse encephalopathy coma of the subjects, as all 3 subjects with diffuse encephalopathy coma had bad MRS score and no subject had good score (p=0.028).
- There was a statistically significant difference present between category of MRS score and GCS score severity (p= 0.032).
- There was a statistically significant difference present between category of MRS score and ICU admission of subjects as among subjects who required ICU admission 8 had bad MRS score and only 2 had good score (p=0.001).
- There was a statistically significant difference present between category of MRS score and requirement of mechanical ventilation as among subjects who required mechanical ventilation support, 4 had bad MRS score and only one had good score (p=0.029).
- There was a statistically significant difference present between category of MRS score and disability as among subjects who reported disability, 9 had bad MRS score and 2 had good score (p=0.001).

CONCLUSION

From the results of the present study, it can be concluded that ONSD is a valid non-invasive triage tool with high sensitivity value which can be used to detect the raised intracranial pressure in patients of CVT. Ultrasonography of the ONSD may serve as a safe, rapid, non-invasive, and low-cost bedside tool for the dynamic and quantitative evaluation of ICP changes, especially if repeated evaluations are needed.

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S. No	MRD No	Name	Age	Sex	Date of admission	Date of Discharge	Present neurological Illness						FOCAL SYNDROME			DIFFUSE ENCEPHALOPATHY	mRS SCORE ON THE DAY OF ADMISSION	ONSD – TIM HOSPITAL A	
							FEATURES OF INTRACRANIAL HYPERTENSION	DURATION OF SYMPTOM	HEADACHE	PAPILLOEDMA	SEIZURES	6th NERVE PALSY	HEMIPARESIS	CRANIAL NERVE DEFICIT	APHASIA	COMA		RIGHT EYE	
																		1ST DAY	4TH DAY
1	1210849	JK	32	F	20/11/21	29/11/21	Y	12DAYS	Y	Y	Y	N	N	N	N	N	1	4.9	4.8
2	781841	PA	37	F	16/07/21	23/07/21	Y	04DAYS	Y	N	Y	N	N	N	N	N	2	4.7	4.7
3	1211125	SK	27	F	20/11/21	26/11/21	Y	02DAYS	Y	Y	N	N	Y	Y	N	N	3	5.2	4.5
4	1138268	SS	28	M	16/07/21	24/07/21	Y	04DAYS	Y	Y	N	N	N	Y	N	N	2	5	4.8
5	1043916	AM	26	M	07/03/21	16/03/21	Y	05DAYS	Y	N	N	N	N	N	N	N	1	4.7	4.7
6	1321192	RK	29	M	11/6/22	01/07/22	Y	06DAYS	Y	N	N	Y	N	N	N	N	1	4.9	4.7
7	1288843	SB	48	F	17/04/22	23/04/22	Y	05DAYS	Y	N	Y	N	Y	Y	N	N	3	5.7	5.3
8	1228332	AR	64	M	19/12/21	30/12/21	Y	03DAYS	Y	Y	Y	N	Y	N	N	N	3	5.1	4.9
9	1142037	RK	90	F	26/07/21	30/07/21	Y	04DAYS	Y	N	N	N	Y	N	N	N	2	5.3	4.9
10	1155965	HS	37	M	23/08/21	27/08/21	Y	02DAYS	Y	Y	N	N	N	N	N	N	2	5.2	4.6
11	154998	HS	36	M	19/08/21	28/08/21	Y	02DAYS	Y	Y	Y	N	Y	N	N	N	3	5.3	4.9
12	1190777	SS	38	F	13/10/21	20/10/21	N	02DAYS	N	N	N	N	Y	N	N	N	2	4.6	6.6
13	828810	RJ	40	F	09/10/21	14/10/21	Y	02DAYS	Y	Y	Y	N	N	Y	N	N	3	5	4.6
14	1185972	RR	45	F	22/03/21	28/03/21	Y	04DAYS	Y	Y	N	N	N	N	N	N	2	4.5	4.5
15	1305938	MS	42	M	17/05/22	25/05/22	Y	03DAYS	Y	Y	Y	N	N	N	N	N	2	5.1	4.5
16	1397407	RS	44	M	15/10/22	19/10/22	Y	07DAYS	Y	Y	N	Y	Y	Y	N	N	2	4.6	4.6
17	1402836	AK	37	F	26/10/22	31/10/22	Y	01DAY	Y	Y	Y	N	Y	N	N	N	2	5.5	4.9
18	1043916	AS	26	M	07/03/21	16/03/21	Y	04DAYS	Y	Y	Y	N	Y	N	N	N	2	4.9	4.8
19	1336020	HS	23	M	05/07/21	11/07/21	Y	02DAYS	Y	Y	N	N	N	N	N	N	2	5.2	4.7
20	1325958	SS	26	M	19/06/22	26/06/22	Y	02DAYS	Y	Y	N	N	N	N	N	N	1	4.9	4.5
21	1373999	SK	41	M	05/09/22	20/09/22	N	06DAYS	N	Y	Y	N	Y	Y	N	N	3	4.4	4.3
22	1347970	RK	28	F	25/07/22	01/08/22	Y	07DAYS	Y	Y	Y	N	Y	N	N	N	3	4.5	4.4
23	1321070	HS	35	M	10/6/22	16/06/22	Y	05DAYS	Y	Y	N	N	N	N	N	N	2	4.7	4.6
24	1292131	AK	24	M	23/04/22	06/05/22	Y	02DAYS	Y	Y	N	N	Y	N	N	Y	4	5.2	4.9
25	1236571	KS	36	M	09/01/22	18/01/22	Y	01DAYS	Y	Y	N	N	Y	N	N	N	3	5.3	4.9
26	1317426	IK	65	F	04/06/22	10/06/22	Y	01DAYS	Y	Y	N	N	N	N	N	N	2	5.4	5.2
27	1232747	CS	30	M	01/01/22	17/01/22	Y	02DAYS	Y	Y	Y	N	Y	N	N	N	2	4.8	4.7
28	1266175	GK	60	F	08/03/22	12/03/22	N	12 DAYS	N	N	N	N	N	N	N	Y	4	4.3	4.3
29	1130023	AD	41	F	30/06/21	15/07/21	Y	03DAYS	Y	Y	Y	N	N	N	N	N	2	5.1	4.7
30	1169166	HS	40	M	07/09/21	19/09/21	Y	04DAYS	Y	Y	Y	N	N	N	N	Y	2	5.2	4.9
31	1424986	RS	41	M	02/12/22	09/12/22	Y	10DAYS	Y	Y	Y	Y	Y	Y	N	N	3	4.6	4.5
32	420144	RG	23	M	25/11/22	30/11/22	Y	10DAYS	Y	Y	Y	N	N	N	N	N	2	4.7	4.4
33	1218421	SK	39	F	09/12/21	16/12/21	Y	05DAYS	Y	Y	N	N	N	N	N	N	1	4.6	4.6
34	1035627	SM	45	M	27/02/21	03/03/21	Y	01DAYS	N	Y	N	N	N	N	N	N	2	5.4	4.9

S. No	MRD No	ME FROM DMISSION		Past History			1. General Physical Examination						GCS			2. Systemic Examination				
		LEFT EYE														Central Nervous System				
		1ST DAY	4TH DAY	o HYPERTENSION	o CAD	TYPE 2 DIABETES MELLITUS	Blood Pressure	Respiratory rate	Pallor	Pedal edema	Cyanosis	Clubbing	EYE OPENING RESPONSE	VERBRAL RESPONSE	MOTOR RESPONSE	higher mental functions	cranial nerves	motor nerves	sensory examination	deep tendon reflex
1	1210849	4.8	4.7	N	N	N	N	14	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
2	781841	4.8	4.7	N	N	N	N	16	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
3	1211125	5.2	4.6	N	N	N	N	17	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
4	1138268	5.1	4.8	N	N	N	N	15	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
5	1043916	4.7	4.6	N	N	N	N	14	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
6	1321192	4.9	4.7	N	N	N	N	15	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
7	1288843	5.8	5.3	Y	N	Y	N	15	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
8	1228332	5.1	4.9	N	N	N	N	14	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
9	1142037	5.3	5	Y	N	N	N	16	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
10	1155965	5.1	4.5		N	N	N	16	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
11	154998	5.2	4.9	N	N	N	N	14	N	N	N	N	E3	V4	M5	ALTERED	NAD	NAD	NAD	NAD
12	1190777	4.7	4.6	N	N	N	N	15	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
13	828810	4.9	4.6		N	Y	N	15	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
14	1185972	4.5	4.6	N	N	N	N	16	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
15	1305938	5.1	4.6	N	N	N	N	15	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
16	1397407	4.5	4.6	N	N	N	N	14	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
17	1402836	5.4	4.9	N	N	N	N	13	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
18	1043916	4.9	4.8	N	N	N	N	14	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
19	1336020	5.2	4.8	N	N	N	N	16	N	N	N	N	E2	V2	M3	ALTERED	NAD	NAD	NAD	NAD
20	1325958	4.8	4.5	N	N	N	N	15	N	N	N	N	E4	V4	M5	NAD	NAD	NAD	NAD	NAD
21	1373999	4.3	4.2	N	N	N	N	17	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
22	1347970	4.5	4.5	N	N	N	N	15	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
23	1321070	4.8	4.7	N	N	N	N	16	N	N	N	N	E4	V4	M6	NAD	NAD	NAD	NAD	NAD
24	1292131	5.3	4.9	N	N	N	N	16	N	N	N	N	E1	V1	M4	ALTERED	NAD	NAD	NAD	NAD
25	1236571	5.3	4.9	N	N	N	N	15	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
26	1317426	5.4	5.1	N	N	N	N	15	N	N	N	N	E4	V5	M6	ALTERED	NAD	NAD	NAD	NAD
27	1232747	4.8	4.7	N	N	N	N	16	N	N	N	N	E3	V1	M5	NAD	NAD	NAD	NAD	NAD
28	1266175	4.3	4.3	N	N	N	N	20	N	N	N	N	E3	V1	M4	NAD	NAD	NAD	NAD	NAD
29	1130023	5.1	4.8	N	N	N	N	16	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
30	1169166	5.3	4.8	Y	N	N	N	18	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
31	1424986	4.6	4.5	Y	N	N	N	13	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
32	420144	4.7	4.3	N	N	N	N	14	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
33	1218421	4.6	4.6	N	N	N	N	15	N	N	N	N	E4	V5	M6	NAD	NAD	NAD	NAD	NAD
34	1035627	5.4	4.8	N	N	N	N	13	N	N	N	N	E4	V3	M6	ALTERED	NAD	NAD	NAD	NAD

S. No	MRD No	plantar reflexes	Respiratory System	Cardiovascular System	Abdomen	OUTCOME					FINAL OUTCOME				SURVIVAL		MRS SCORE
						LENGTH OF THE HOSPITAL STAY	MORTALITY	ICU ADMISSION	REQUIREMENT OF MECHANICAL VENTILATION	COMPLICATIONS	SURVIVAL	DISABILITY	DEATH	DAMA	GOOD (MRS < 0.2)	BAD (MRS BETWEEN 3-5)	
1	1210849	FLEXOR	NAD	NAD	NAD	09DAYS	N	N	N	N	Y	N	N	N	Y	N	1
2	781841	FLEXOR	NAD	NAD	NAD	08DAYS	N	N	N	N	Y	N	N	N	Y	N	2
3	1211125	FLEXOR	NAD	NAD	NAD	06 DAYS	N	N	N	N	Y	N	N	N	Y	N	2
4	1138268	FLEXOR	NAD	NAD	NAD	09DAYS	N	Y	N	N	Y	N	N	N	N	Y	3
5	1043916	FLEXOR	NAD	NAD	NAD	10DAYS	N	N	N	N	Y	N	N	N	Y	N	2
6	1321192	FLEXOR	NAD	NAD	NAD	20DAYS	N	N	N	N	Y	Y	N	N	Y	N	2
7	1288843	FLEXOR	NAD	NAD	NAD	06DAYS	N	N	N	N	Y	Y	N	N	N	Y	2
8	1228332	FLEXOR	NAD	NAD	NAD	11DAYS	Y	N	N	N	Y	N	N	N	Y	N	2
9	1142037	FLEXOR	NAD	NAD	NAD	05DAYS	N	N	N	N	Y	N	Y	N	Y	Y	2
10	1155965	FLEXOR	NAD	NAD	NAD	11DAYS	N	N	N	N	Y	N	N	N	Y	N	2
11	154998	FLEXER	NAD	NAD	NAD	10DAYS	N	Y	N	N	Y	Y	N	N	N	Y	4
12	1190777	FLEXOR	NAD	NAD	NAD	08DAYS	N	N	N	N	Y	N	N	N	Y	N	2
13	828810	FLEXOR	NAD	NAD	NAD	06DAYS	N	N	N	N	Y	N	N	N	Y	N	2
14	1185972	FLEXOR	NAD	NAD	NAD	07DAYS	N	N	N	N	Y	N	N	N	Y	N	2
15	1305938	FLEXOR	NAD	NAD	NAD	09DAYS	N	N	N	N	Y	N	N	N	Y	N	2
16	1397407	FLEXOR	NAD	NAD	NAD	05DAYS	N	N	N	N	Y	N	N	N	Y	N	1
17	1402836	EXTENSOR	NAD	NAD	NAD	06DAYS	N	N	N	N	Y	N	N	N	N	Y	3
18	1043916	FLEXOR	NAD	NAD	NAD	10DAYS	N	N	N	N	Y	N	N	N	Y	N	2
19	1336020	EXTENSOR	NAD	NAD	NAD	07DAYS	Y	Y	Y	Y	N	Y	Y	N	N	Y	6
20	1325958	EXTENSOR	NAD	NAD	NAD	07DAYS	N	N	N	N	Y	N	N	N	Y	N	1
21	1373999	FLEXOR	NAD	NAD	NAD	16DAYS	N	Y	N	N	Y	Y	N	N	N	Y	3
22	1347970	EXTENSOR	NAD	NAD	NAD	06DAYS	N	N	N	Y	Y	Y	N	N	N	Y	3
23	1321070	EXTENSOR	NAD	NAD	NAD	07DAYS	N	N	N	N	Y	N	N	N	Y	N	2
24	1292131	EXTENSOR	NAD	NAD	NAD	14DAYS	N	Y	Y	Y	Y	Y	N	N	N	Y	4
25	1236571	EXTENSOR	NAD	NAD	NAD	10DAYS	N	N	N	N	Y	N	N	N	Y	N	3
26	1317426	EXTENSOR	NAD	NAD	NAD	07DAYS	N	N	N	N	Y	N	N	N	Y	Y	1
27	1232747	EXTENSOR	NAD	NAD	NAD	17DAYS	N	Y	Y	N	Y	N	N	N	Y	N	2
28	1266175	FLEXER	NAD	NAD	NAD	05DAYS	N	Y	Y	Y	N	Y	N	Y	N	Y	5
29	1130023	FLEXOR	NAD	NAD	NAD	15DAYS	N	N	N	N	Y	N	N	N	Y	N	1
30	1169166	EXTENSOR	NAD	NAD	NAD	13DAYS	Y	Y	Y	Y	N	Y	Y	N	N	Y	5
31	1424986	EXTENSOR	NAD	NAD	NAD	09DAYS	N	Y	N	Y	Y	Y	N	N	N	Y	3
32	420144	FLEXOR	NAD	NAD	NAD	06DAYS	N	N	N	N	Y	N	N	N	Y	N	1
33	1218421	FLEXOR	NAD	NAD	NAD	08DAYS	N	N	N	N	Y	N	N	N	Y	N	1
34	1035627	MUTE	NAD	NAD	NAD	05DAYS	N	Y	N	N	Y	Y	N	N	Y	N	2

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Date 25/11/22

The Principal,
DMC, Ludhiana.

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 29.10.2021 has approved the plan of thesis of **Bhagwant Singh**, a student of your college for **MD General Medicine** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
Association of optic nerve sheath diameter (onsd) on ultrasound with prognosis in acute cerebral venous thrombosis (cvt).

Supervisor
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The student has to submit the four copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

S P Singh

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

43. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*
44. *The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

ASSOCIATION OPTIC NERVE SHEATH DIAMETER (ONSD) ON ULTRASOUND WITH PROGNOSIS IN ACUTE CEREBRAL VENOUS THROMBOSIS (CVT)

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MD

MEDICINE

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

March 2021

Dr Bhagwant Singh

DEPARTMENT OF MEDICINE

DAYANAND MEDICAL COLLEGE AND HOSPITAL

LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	ASSOCIATION OF OPTIC NERVE SHEATH DIAMETER (ONSD) ON ULTRASOUND WITH PROGNOSIS IN ACUTE CEREBRAL VENOUS THROMBOSIS (CVT)
For the degree of	MEDICINE
Name of the candidate	BHAGWANT SINGH
Supervisor	Dr Dinesh Jain, Professor, Department of Medicine, DMC & H Ludhiana
Co-supervisor	Dr Birinder Singh Paul, Professor, Department of Neurology, DMC&H Ludhiana Dr Gunchan Paul, Associate professor, Department of critical care, DMC&H, Ludhiana
Institution	Dayanand Medical College & Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Cerebral venous thrombosis (CVT) is a condition characterized by thrombosis of intracranial sinuses and veins that results in parenchymal damages and can cause increased intracranial pressure.

Aim of Study: The aim of the study is to find association of the optic nerve sheath diameter changes with prognosis in acute cerebral venous thrombosis patients.

Materials & methods: This will be an observational prospective study conducted in the department of emergency medicine at Dayanand Medical College and Hospital (DMC&H), Ludhiana on patients diagnosed with acute cerebral venous thrombosis (CVT) and optic nerve sheath diameter of both the eyes will be done with the ultrasound. The study will be conducted over a period of 1 and half years

Clinical Significance: The present study will help in determining the association of changes in optic nerve sheath diameter(ONSD) with the outcomeof patients with acute cerebral venous thrombosis and thus helpful in deciding the better management of CVT patients

Keywords: Cerebral vein thrombosis, mRS, OND, outcome.

(Signature)	(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"ASSOCIATION OF OPTIC NERVE SHEATH DIAMETER (ONSD) ON ULTRASOUND WITH PROGNOSIS IN ACUTE CEREBRAL VENOUS THROMBOSIS (CVT)"** exist in the Department of General Surgery, DMC&H, Ludhiana and will be provided to be candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate himself under our supervision and guidance.

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APPROVAL PROFORMA
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Approved: Yes / No

Dr. Sandeep Puri
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Approved: Yes / ~~No~~

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PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

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3	COURSE OF STUDY AND SUBJECT	MD Medicine
4	DATE OF ADMISSION OF COURSE	26th JULY 2020
5	TITLE OF THE TOPIC	ASSOCIATION OPTIC NERVE SHEATH DIAMETER (ONSD) ON ULTRASOUND WITH PROGNOSIS IN ACUTE CEREBRAL VENOUS THROMBOSIS (CVT)

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Cerebral venous thrombosis (CVT) is rare with an incidence of 0.22–1.32/100,000/year.[1] It is responsible for 0.5% of stroke patients presenting to the hospital.[2] It is three times more common in females than in males.[3,4]

The principle pathology of CVT is thrombosis of cerebral veins and the commonest site of origin is believed to be the junction of cerebral veins and larger sinuses.[5] The clinical presentation of CVT is variable and falls broadly into three categories: symptoms and signs of raised intracranial pressure (ICP), a focal brain lesion, or both a focal lesion and raised ICP. Even the mode of onset is variable where up to 40% of patients present acutely with a stroke-like syndrome within 48 h of symptom onset and other half may present within 1 month of symptom onset.[6] Overall Presenting clinical features can depend on the location of the thrombus and the extent of raised ICP, including whether it is related to venous pressure alone or extensive parenchymal damage. Headache is the most common symptom and is present in ~90% of cases; and in 25% of patients, it is the only symptom reported.[7]

Cerebral venous thrombosis can be provoked or unprovoked and numerous risk factors can coexist in individual patients.[7-9]Up to 90% of patients with CVT have at least one risk factor for venous thromboembolism (VTE), and thrombophilias (genetic or acquired) are detected in more than 30% of patients.[10]Other risk factors include presence if infection, inflammation or malignancy.[3]

Once a thrombus is formed in the cerebral or cortical veins, its extension can occlude large draining venous sinuses. This creates physiological back pressure in the venous system, leading to cerebral oedema and, in some cases, infarction and hemorrhage. Dural sinus thrombosis is also thought to reduce cerebrospinal fluid absorption and thereby elevate intracranial pressure (ICP), which is an acute medical event associated with poor clinical outcomes in neurological settings.[3,11]

Direct assessment methods, such as lumbar puncture (LP) and intraventricular catheterization, are commonly used to detect ICP. However, these invasive techniques can result in complications, such as hemorrhaging and bacterial colonization,[12,13] and involve pain and discomfort, especially if repeated evaluations are needed. In addition, invasive ICP monitoring is sometimes unavailable in intensive care units or to patients with certain serious conditions. Given this, non-invasive, repeatable, simple methods for assessing ICP are urgently needed.[14]

Recently, measuring the optic nerve sheath diameter (ONSD) via ultrasound has been proposed as a non-invasive clinical technique for detecting elevated ICP.[15,16] However, this technique was used to evaluate the elevated ICP caused by severe traumatic brain injury and few studies reported the cases that prompt this technique could dynamically assess the efficacy of management of elevated ICP.[14]

Since the subarachnoid space of the optic nerve is a continuum with the intracranial cerebrospinal fluid (CSF) spaces, it can be expanded by an increase of ICP and modify the ONSD. Acute and chronic diseases with an increase in ICP (e.g., idiopathic intracranial hypertension, craniocerebral trauma, malignant middle cerebral artery stroke, intracranial hemorrhage, decompensated hydrocephalus) lead to an increase of ONSD. In cases where the increase of ICP persists, a congested papilla develops with optic disc elevation (ODE), which can be detected with ultrasonography. Furthermore, some recent papers indicate that a diminution of ICP can provoke a decrease in ONSD. Dynamic measurement including a comparison of lying and standing positions can then help further to identify symptomatic intracranial hypotension.[17,18]

A variety of potential applications of ONSD has been explored, important being detecting high ICP in Intracranial hemorrhage and ischemic stroke. Naldi et al. reported sensitivity and specificity of 100% for ONSD for the detection of increased ICP compared to the Doppler indices, among patients of ICH.[19]Skoulodik et al.[20] found an enlarged ONSD even in the hyperacute phases of acute ICH within 6 h of the

symptom onset ($p < 0.0083$), with the best cut-off point to predict intracranial hemorrhage volume of > 2.5 cm^3 corresponding to an ONSD enlargement of > 0.66 cm (> 21%), with 90.3% accuracy and interrater reliability of 0.760 (95% CI 0.509 to 1.000). Gokcenet al.[21] found that ONSD could identify middle cerebral artery (MCA) stroke patients at high risk of developing ma- lignant MCA syndrome, permitting early diagnosis of a possible ICP increase using ONSD with the possible benefit of decreasing mortality and morbidity in patients with cerebrovascular diseases. This was also shown in the study by Albert et al.[22] Barring few studies,[14] literature lacks research showing the use of USG guided ONSD measurement in patients with CVT, however the fact seems convincing that patients of stroke are prone to increased levels of ONSD and its cut off may be used to predict the increasing ICP which may lead to poor outcomes. In the neurological settings, this association of increase in ONSD among CVT patients may be helpful in deciding a preventable course of management for the patients.

Thus, the present study will be conducted to determine the ONSD diameter changes in CVT patients and its association with short term outcomes. The knowledge of the changes in ONSD diameter with the occurrence of CVT may help in predicting the rise in ICP that may have implications in the management. The study results shall be helpful for better management of CVT subset of patients who present in the neurological settings.

6.2 REVIEW OF LITERATURE

ONSD is an underestimated imaging modality that deserves wider acceptance because this bedside tool allows for fast and safe real-time assessment of conditions associated with elevated intra- cranial pressure, such that a routine inclusion of ONSD measurement in the multimodal monitoring of patients in neurocritical care can be recommended.[17,23]

ONSD measurement, together with invasive ICP monitoring, is valuable for neurological conditions with clinically suspected variation of ICP such as CVT and in optic nerve disorders. Currently, the biggest limitation of this technique is the marked variability in ONSD reported across studies in healthy subjects and subjects with pathological conditions.[17]

In this literature review, we discuss the studies that evaluated ONSD in stroke patients with either arterial or venous causes or cerebral hemorrhage.

Previous empirical studies

Skoloudík D et al,[20] (2011) included 31 acute intracerebral haemorrhage (ICH) patients, 15 age-matched acute ischemic stroke patients and 16 age-matched healthy volunteers. It was found that in acute ICH patients, a significant enlargement of ONSD was detected ($p < 0.0083$). The best cut-off point to predict ICH volume >2.5 cm^3 was the relative ONSD enlargement of > 0.66 mm (> 21 %), with 90.3% accuracy and kappa coefficient 0.760 (95% CI 0.509 to 1.000). Results showed that sonographically measured enlargement of the ONSD may be detectable in the hyperacute stage of increased intracranial pressure.

Bäuerle J et al,[24] (2016) studied 27 patients with aneurysmal subarachnoid hemorrhage (SAH) and found that in spite of the normal mean ICP values, ONSD was significantly greater in patients with SAH than that of healthy volunteers. No relevant decline of ONSD over time was found. Additionally, there was no correlation between ONSD and ICP. Results showed that in patients with SAH and acute hydrocephalus after aneurysm rupture, the ONSD was expanded after

normalization of ICP. This may be probably because of an impaired retraction capability of the optic nerve sheath. This finding should be considered when using transorbitalsonography in the neuromonitoring of aneurysmal SAH.

Albert et al,[22] (2017) in study included a total of 19 patients with malignant MCA stroke and 19 patients with nonmalignant MCA stroke were enrolled. It was found that mean ONSD, ONSD/ETD (eyeball transverse diameter) ratio, midline shift (MLS), and infarct volume on initial CT all significantly increased after developing malignant MCA syndrome and decreased (except infarct volume, which increased) following DC (P<.05). ONSD and ONSD/ETD ratios in the malignant group did not correlate with functional outcomes but were significantly higher on initial CT compared with the nonmalignant group (mean ONSD: 5.66 mm versus 4.97 mm, P = 0.001; mean ONSD/ETD ratio: 0.25 versus .22, P = 0.002). Results showed that ONSD, ONSD/ETD ratio, MLS, and infarct volume change dynamically in patients with malignant MCA infarction who undergo DC. An ONSD of > 5.25 mm and an ONSD/ETD ratio of > .232 on initial CT may identify MCA stroke patients at high risk of developing malignant MCA syndrome.

Gökcen E et al,[21] (2017) in the study included the patients with the symptoms of stroke. Patients were categorized into four subgroups as per Oxfordshire Community Stroke Project classification (OCSP). It was found that on comparing the right and left ONSDs of CVD group and control group, the results were statistically significant (p<0.001). When the CVD subgroups were compared with the control group in terms of right and left ONSDs, the highest right-left ONSD was detected to be in TACI (total anterior circulation infarction) group (p<0.001). Results showed that in the early cases of CVD, mortality and morbidity can be reduced by the early diagnosis of the possible existence of ICP increase as per the ONSD level.

Yesilaras et al,[25] (2017) in study included 61 patients with spontaneous SAHs and equal number of control patients. The median ONSD for control was significantly lesser than spontaneous SAH (5.76 vs. 6.72 mm, p<0.001). The AUC (area under the receiver operating

characteristic curve) was determined as 0.791 (CI 95%, 0.710-0.872). At an ONSD threshold value of 6.1 mm, the sensitivity and specificity of SAH was 72%. No significant relationship between ONSD and in-hospital mortality in spontaneous SAH patients ($p>0.05$) was observed. The intraclass correlation coefficients for inter- and intrarater reliability were 0.84 and 0.95, respectively. Results showed that in patients who have spontaneous SAH, the ONSD measured in the orbital sections of a head CT was strongly correlated with a SAH diagnosis. Assessment of ONSD in head CTs taken with spontaneous SAH suspicion may be helpful in the diagnosis of spontaneous SAH.

Wang et al,[14] (2020) conducted study with aim to evaluate the clinical cases of the changes in ICP with venous sinus stenosis. ONSD and ICP were dynamically monitored as a lens for understanding the dynamic assessment for ICP. Two cases were studied: first case was of venous sinus stenosis with increased ICP recognized in real-time by changes in ONSD, which were correlated with ICP before and after stenting. Second case was of venous sinus thrombosis with increased ICP. Following treatment, the patient underwent an ultrasound ONSD examination and lumbar puncture (LP) at the 1st, 2nd, and 3rd month of follow-up. The previously enlarged ONSDs retracted and LP opening pressure gradually returned to normal. Findings of these cases indicated that ONSD examination may help to dynamically evaluate ICP changes and assess the efficacy of ICP treatment. These results provide utile, evidence based, preliminary clinical recommendations and indicate that ONSD examination may be a beneficial method of assessing ICP, particularly if repeated evaluations are required.

Literature is sparse in terms of association of ONSD changes in patients with CVT. Thus the present study holds importance in the clinical neurology practice for this subset of patients.

6.3 AIMS AND OBJECTIVES OF THE STUDY

- To study the relationship between Optic Nerve Sheath Diameter (ONSD) with acute CVT(cerebral venous thrombosis) during hospital stay and in-hospital mortality.
- Primary outcome is death or disability
- Disability will be assessed by mRS mRS >> 3

  << 3
- Secondary outcome will be duration of hospital stay and need for mechanical ventilation.

7.0 MATERIALS AND METHODS

This study will be conducted at Dayanand Medical College and Hospital, Ludhiana on patients who are diagnosed with CVT by CT scans in the neurology department.

7.1 SOURCE OF DATA

This will be Prospective Observational Cohort Study to be conducted on all patient diagnosed with CVT; fitting into the inclusion criteria of the study in the department of medical emergency and neurology of DMCH, Ludhiana over a period of 1 and half years from 1st March 2021 to 31st Aug 2022.

7.2 METHOD OF COLLECTION OF DATA

All patients diagnosed with CVT and willing to participate in the study after giving informed consent will be included in the study.

A demographic history (age,gender) and clinical history regarding presenting symptoms will be obtained in the pre-designed study proforma. The patients will be investigated with USG guided ONSD and ICP measurements. Outcome of the patient will include hospital stay, and in-hospital mortality

Inclusion Criterion:

- Age more than 18 years
- Patients diagnosed with acute CVT
- Both male and female patients

Exclusion Criterion:

- Consent not available
- Age < 18 years
- Patient with traumatic brain injury
- Patients having orbital trauma
- Patient with Previous history of cranial injury
- Patients with history of glaucoma, amblyopia, or diseases of the optic nerve.

METHODOLOGY: A written informed consent will be obtained from the patients who will satisfy the eligibility criteria. After enrolment into the study, demographic and clinical history pertaining to age, gender, personal history, family history, occupation, smoking and alcohol habits

shall be obtained at the time of presentation. The patients will be clinical examined for general physical assessment (vitals and BMI). The details regarding the presentation of symptoms will also be recorded.

The patients will be investigated with USG guided ONSD measurements and the values will be compared against the normative ONSD data of the control group.[24] Ultrasound examinations of the eye will be carried out in B-mode by one experienced emergency physician/ resident.

Duration of Study / Number of Cases: 18 months from 1st March 2021 to 31st Aug 2022.

Outcome:

The patients shall be admitted and shall be monitored for determining the overall length of hospital stay. During the period of stay, use of mechanical ventilation, and any adverse complications shall be reported. The patients will be followed till the day of discharge or death.

Statistical Analysis:

Data will be described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. All statistical calculations will be done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

No.

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Yes

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PROFORMA

Sr. No

Patient's Name: Age: Sex:

Address:

MRD No.:

Date of admission_____ Date of Discharge_____

Present neurological Illness:

FEATURES OF INTRACRANIAL HYPERTENSION

DURATION OF SYMPTOM

HEADACHE

PAPILLOEDMA

SEIZURES

6th NERVE PALSY

FOCAL SYNDROME:

HEMIPARESIS

CRANIAL NERVE DEFICIT

APHASIA

DIFFUSE ENCEPHALOPATHY

COMA

mRS SCORE ON THE DAY OF ADMISSION

Signature of Candidate **Signature of Supervisor**

ONSD – TIME FROM HOSPITAL ADMISSION

RIGHT EYE **LEFT EYE**

1ST DAY -

4TH DAY

Past History:

- HYPERTENSION
- CAD
- TYPE 2 DIABETES MELLITUS

1. **General Physical Examination**:

Built: Weight-

Pulse: Blood Pressure:

Temperature: Respiratory rate:

Pallor / Pedal edema / Cyanosis / JVP / Clubbing

GCS :- EYE OPENING RESPONSE _ / VERBRAL RESPONSE _/ MOTOR RESPONSE_

2. **Systemic Examination**:

Central Nervous System:

-higher mental functions
- cranial nerves
-motor nerves
-sensory examination
-deep tendon reflex
-plantar reflexes

Signature of Candidate **Signature of Supervisor**

Respiratory System:

Cardiovascular System:

Abdomen:

OUTCOME

- LENGTH OF THE HOSPITAL STAY
- MORTALITY – YES/NO
- ICU ADMISSION – YES/NO
- REQUIREMENT OF MECHANICAL VENTILATION – YES/NO
- COMPLICATIONS - YES/NO

FINAL OUTCOME:- SURVIVAL / DIS-ABILITY / DEATH / DAMA

SURVIVAL---- GOOD (MRS < 0.2)

BAD (MRS BETWEEN 3-5)

MRS SCORE	CLINICAL DESCRIPTION
0	NO SYMPTOMS
1	NO SIGNIFICANT DISABILITY
2	SIGNIFICANT SLIGHT DISABILITY
3	MODERATE DISABILITY , REQUIRES SOME HELP
4	MODERATE SEVER DISABILITY
5	SEVER DISABILITY
6	DEAD

Signature of Candidate **Signature of Supervisor**

INFORMED PATIENT CONSENT

Date: _____

I..... D/o, W/o, S/o.....

.....am willing to participate in the study **"ASSOCIATION OF OPTIC NERVE SHEATH DIAMETER (ONSD) ON ULTRASOUND WITH PROGNOSIS IN ACUTE CEREBRAL VENOUS THROMBOSIS (CVT)"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____

इस शोधकार्य "ASSOCIATION OF OPTIC NERVE SHEATH DIAMETER (ONSD) ON ULTRASOUND WITH PROGNOSIS IN ACUTE CEREBRAL VENOUS THROMBOSIS (CVT)" में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"ASSOCIATION OF OPTIC NERVE SHEATH DIAMETER (ONSD) ON ULTRASOUND WITH PROGNOSIS IN ACUTE CEREBRAL VENOUS THROMBOSIS (CVT)" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ